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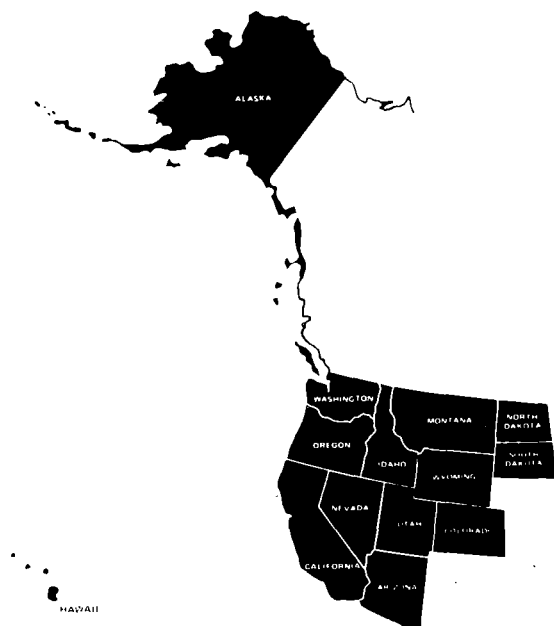
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Western Regional Remote Sensing Conference Proceedings - 1979

Proceedings of a conference held
at the Naval Postgraduate School
Monterey, California
October 17-19, 1979



NASA



NASA Conference Publication 2148

Western Regional Remote Sensing Conference Proceedings - 1979

Proceedings of a conference sponsored
by NASA Ames Research Center and held
at the Naval Postgraduate School,
Monterey, California
October 17-19, 1979



National Aeronautics
and Space Administration

Scientific and Technical
Information Branch

1980

FOREWORD

In October 1979, NASA Ames Research Center sponsored the first Western Regional Remote Sensing Conference, held at the Naval Postgraduate School in Monterey, California. The conference attracted nearly 300 participants and featured more than 50 speakers. During the three days of talks and panel discussions, remote sensing users from 14 western states explained their diverse applications of Landsat data, discussed operational goals and exchanged problem solutions.

In addition, the Monterey meeting stressed the need for increased cooperation among state and local governments, private industry and universities to aid NASA's objective of "transferring to user agencies, the ability to operationally use remote sensing technology for resource and environmental quality management."

The text of the proceedings was produced by the Bendix Field Engineering Corporation, from summaries supplied by the speakers and chairpersons and from edited versions of recorded transcriptions. Where summaries were not available, notes and transcriptions were used to present the main concepts of the speakers address. Our apologies for any omission or misrepresentation.

Alfred C. Masey
Conference Chairman

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SESSION I

17 OCTOBER 79 WEDNESDAY (AM)

WESTERN REGIONAL REMOTE SENSING CONFERENCE
CONVENED AT
THE NAVAL POST GRADUATE SCHOOL
KING HALL
MONTEREY, CALIFORNIA

SPONSORED BY NASA AMES RESEARCH CENTER
MOFFETT FIELD, CALIFORNIA

A INTRODUCTION

Alfred C. Mascy (Conference Chairperson - Manager WRAP
Information Services)

Good Morning and welcome to the Western Regional Remote Sensing Conference. The purpose of this conference is to provide a forum for the exchange of ideas and experiences among the three equally important elements of University/Government/Industry. Our program will try to focus on each of these elements so necessary for the successful utilization of Remote Sensing Technology.

Designed to enhance user's awareness, the conference will focus on three areas of applications: land use in urban areas, forestry and agriculture. Formal panels on state task force concepts, user needs assessments, and operational use and transfer of remote sensing technology, should provide a cross-region sampling of the latest methods and theory available to users. Sessions on data bases and geographic information systems, federal programs and private industry's work in remote sensing, along with pre-designated luncheon speakers addressing special formal topics as part of the scheduled agenda will round out the program.

Our next three speakers will provide the setting leading into our scheduled sessions. Dr. Dale Lumb will give an overview of the Western Regional Applications Program and Mr. Richard Weinstein will present NASA's perspective on the remote sensing program.

Here with us this morning to give us a proper welcome is Mr. C.A. Syvertson. Mr. Syvertson, the Director of NASA Ames Research Center, has demonstrated a most distinguished and noteworthy career. Among many accomplishments and awards - Sy has received the NASA Exceptional Service Award, The Lawrence-Sperry Award, The Space Act Inventions Award. Additionally, he was named a Fellow of The American Institute of Aeronautics & Astronautics and a Fellow of The American Astronomical Society. I could go on but our schedule will not permit, so therefore let me now turn to Sy Syvertson.

B

WELCOME

C.A. Syvertson (Director - NASA Ames Research Center)

Welcome! As many of you are aware, NASA's program has many and varied elements. Our activities cover everything from Aeronautics to Planetary Exploration, from development of Space Transportation Systems, such as the Shuttle, to Astronomy and the Life Sciences of Space Applications. For Aeronautics and for Space Applications, NASA's role is significantly different from its role in other disciplines. The role is different because NASA itself is not the User of the technology we develop. In Aeronautics, NASA does not build the aircraft, but develops technology for those who do.

For more than 60 years, NASA and its predecessor agency have developed highly successful working relationships with aircraft and engine manufacturers, the airlines and the military services. Part of this success stems from the fact that during the past 6 decades the participants have literally grown up together. In addition, NASA's aeronautics constituency is relatively restricted and their individual roles are relatively well defined.

In Space Applications, NASA, again, is not the user of the information it gathers, but, rather, that information is provided for others to apply. There its similarity with aeronautics ends however. NASA's space applications constituency is broad, having far more varied and diverse interests. Even more importantly, almost all the users existed long before the space age began. They had well-developed methods of doing business. NASA is the new boy on the block and must continue to work hard to become accepted.

I have always felt that Ames Research Center has one of the most diverse programs at NASA because we work in all the areas noted earlier, - Aeronautics, Planetary Exploration, Astronomy, Life Sciences supporting the development of Space Shuttle and, successfully I hope, in space applications. Yet for all the different disciplines represented at Ames Research Center, variations are small compared to those represented in this room. Here today we will have geographers, fish and game program managers, land use planners, natural resource managers, agriculturalists, foresters, photographers, information specialists and more. We have people representing state and local governments, universities, industries and other federal agencies. Although this group is broad, I am certain that not all the space applications user community is represented. It is also true that most of the organizations represented here were in business long before NASA's inception.

NASA recognizes the environment in which the Applications Program must operate. This recognition was one factor that led to establishment of the Regional Applications Program. Ames has responsibility for the Western Region, which includes 14 states. We are trying to build on our previous experience - for example, with the Pacific Northwest states of Washington, Oregon and Idaho - to develop necessary working relationships with established organizations from all 14 states. One part of our approach is to bring user community representatives together at a conference such as this. It is exceedingly important that NASA understand user community needs and the constraints under which it operates. We should all recognize that exchanges such as those that will occur during the next several days are important to NASA's executing an effective applications program.

In many ways, Space Applications represent a maturing space program. That is significant since NASA's birthday is 1 October and this year it is 21 years old, perhaps an appropriate time to mature.

The Space Applications Program overall objective is not exploration but rather practical utilization of space for the benefit of a much larger population segment than was involved in space exploration. We hope material presented and discussed during the next several days at this conference will contribute to that objective, while helping you become more familiar with some recent remote sensing applications. At the same time, we are certain it will help us become more familiar with your requirements as users. Those requirements will certainly be considered in future applications of remote sensing. With your help and active participation, we are committed to make this program as effective and successful as we believe the Aeronautics Program has been.

Again, Welcome and I hope you enjoy the conference.

C

NASA PERSPECTIVE

Richard H. Weinstein (Manager - Regional Applications Program
NASA Headquarters)

As those of you who have the preliminary program schedule have seen - I was not listed on the program. Last week, Dale called me and he said, I've got good news and I've got bad news. The good news is that I'd like you to make a couple of introductory remarks at the conference. The bad news is that we have not allowed any more time and I expect you to keep us on schedule. So I'll try to keep the remarks brief.

Dale did ask me to provide an overview on where I thought the program stood now, what we planned to do and where I see us going. The regional program, as mentioned, was established 2 years ago.

As you are all aware, this is a technological transfer program and our objective is to transfer to state and local governments, the ability to use remote sensing for resource and environmental quality management. The program's focus is indeed on state government, because our interest is in remote sensing applications. The program is necessarily conservative in nature in the types of technologies we address, although we have worked with states on resource and development to explore the feasibility of new technologies.

Objectives of this program are, in fact, much more with established technologies rather than advanced technologies. Emphasis has been on the Landsat satellite and, in particular, on digital processing of Landsat data for two reasons. First, because of our conviction that this offers a highly effective way to use data. Second, the user community identified information systems, particularly digital information systems which are advancing rapidly. The digital mode turns out to be an effective way of enabling states to gain access to new data types such as that provided by Landsat.

When the program was established, it consolidated a number of efforts that had previously been proceeding on an "ad hoc" basis within NASA. We divided the states into regions. Next, we assigned responsibility for dealing with each state in a region to one of the NASA Field Centers possessing an established capability for doing earth resource type activities. Ames is responsible for 14 western states, the National Space Technologies Laboratories in Slidell, Louisiana is responsible for 17 southern states, and the Goddard Space Flight Center in Greenbelt, Maryland is responsible for the 19 northeast, north central states.

The program has 4 principal functions. Following up national scale activities with national representative organization, - for example, the National Conference of State Legislatures and National Governor's Association, - the regional program contacts states on an individual basis to provide them with information through the liaison function. Moreover, the program provides them with information on what Landsat can do, how it is in use, how it has been used and how other states are using it. In other words, the program initiates the process of developing concrete programs to provide states with a basis for making a decision as to whether they wish to utilize Landsat on an operational basis in their own programs.

Once such a program is established, NASA moves on to the next phases which include training and demonstration projects. Training objectives include preparing state participants for demonstration projects - which we feel are really the core of the program, - and also to begin development of a long standing capability on which the state can rely if and when they decide to use satellite data on an operational basis. Looking back over almost 3 years since the program was established, we have trained approximately 700 people from state agencies across the country in digital analysis techniques, the hands-on type of analysis needed to really do useful jobs with Landsat data. In addition, we have provided orientation sessions to more than twice that number. This group consists of many state policy officials, because eventual Landsat data use in state programs involves not only technical decisions, but also policy commitments on the states part.

We believe demonstration projects are the program core. It is easy to tell an individual state what has gone on in Florida, Louisiana, New York or Pennsylvania, but it is difficult to believe that it would apply in Oregon, Utah and California unless you have seen it yourself. That is exactly what demonstration projects are designed to provide, - a hands-on exposure to using satellite data in the states own context. We try to develop demonstration projects as multi-agency, multi-discipline projects so a state will gain an "across-the-board" exposure to the data's utility and whether a commitment should be made on a statewide basis.

Finally, where some decision has been made to continue data use, we try to provide technical assistance through internal NASA capabilities, such as available software, sharing our experience in a particular type of application, and guiding users to the continuing sources of support that we find in industrial and academic communities.

Since 1977, we have involved some 24 states in demonstration projects through the regional program. More than half of those have been initiated during the past year. Together with the multi-disciplinary projects conducted through the ASVT Program, another NASA demonstration program, we

have now dealt with more than half of our nation's states on a multi-disciplinary basis to give them some hands-on exposure to Landsat. Currently, about 90 different applications are being investigated by the states in these demonstration projects. Great emphasis has been placed on land use, forestry and agriculture, but considerable interest also exists in specialized topics such as wildlife habitats and coastal zone management.

When the context of these 3 regional conferences began to be discussed 1 year ago, we had 3 objectives in mind. First, we had interest in establishing a benchmark on the states use of Landsat data. Many people at management policy levels are not aware of the extent to which they have used Landsat and are continuing to develop programs to expand that use. We felt that such a benchmark would be useful not only to NASA in guiding our future programs, but also for those policymakers in Washington and to the states. As I pointed out, our emphasis is technology transfer. That means NASA is not a service organization but rather a catalyst. Once we feel the transfer job has been accomplished, the continuing responsibility for using data resides largely with the states themselves. An essential element of that is communication between users. We regard these conferences as one opportunity to provide that.

The second objective involved the private sector. In many states, they have built internal capabilities to utilize Landsat data. The need for improving those capabilities in using specialized services and during interim activities will be a growing role of the private sector. We regard this conference as one opportunity to bring together end users and those elements of the private sector that will be future suppliers to discuss problems and share experiences.

Turning to the program's future, we expect to continue our technology transfer to complete projects in states with which we are currently working, and also expose other state governments to Landsat use. By the end of 1981 we hope to have provided a demonstration and transfer opportunity within all 50 states. But before that job is completed, we will begin to move into other areas. Substate governments such as counties, municipal areas, councils of government, and regional commissions have use for Landsat data. We hope to start addressing those areas, particularly county governments, in the coming year. These users tie into state systems and we see that as a very symbiotic relationship.

The final objectives is federal agencies. Many of the demonstration projects we implement result from federally mandated requirements imposed on a state. These laws includes HUD Comprehensive Planning, EPA nonpoints source pollution, coastal zone management, surface mining and dam inventories.

In the long run, states will seek assistance from these federal agencies in using remote sensing to implement regulation requirements. We hope to involve these federal users more and more in demonstration projects now being conducted that relate to this type of legislation. We have already alluded to the need for private sector involvement. As we finish our own transfer activities and begin transition to operational use, we hope to work with states in helping them utilize capabilities that are growing rapidly in the private sector.

Finally, although NASA sees its role in Landsat technology as finite, it does expect to become involved with other programs in a continuing technology transfer effort. For instance, right now the Return Beam Vidicon (RBV), a high resolution sensor, is available. Our agency is looking forward to Landsat 'D' and other technologies. We expect to involve states, sub-state governments and perhaps after that, the private sector user community, with which we have had relatively little contact to date. NASA is firmly convinced that commercial capabilities and the availability of multifaceted applications should be a near term thing. Our agency hopes to work with you on that.

I am looking forward to this conference very much and to hearing in detail about the methods and experiences on each of your programs. I wish each of you success with the programs.

D

PROGRAM OVERVIEW

Dr. Dale R. Lumb

(Chief - Technology Applications Branch
NASA Ames Research Center)

I would like to present a point of view of the program which has to do with its implementation from one of the regional centers. I think that a lot of things Dick said really set the stage for what the program is all about and what the conference is all about.

As Mr. Weinstein pointed out, I had the full 20 minutes and was able to give away half of it but did not find any takers on the other half. So I will do my best here to give some sort of perspective. After that, we will sit down and listen to people who are heavily involved in the program. We hope that we are more or less the catalyst for behind the scenes activities that encourage and foster use of the technology, and, that when it comes to reporting what is happening, we are really preparing charts and material of things accomplished by the users. Those are the people who really count and that is an important point I want to make.

We have now had 3 people say that Ames has the 14 western states, including Hawaii and Alaska. Of course, we have people associated with these different states, and there was no lack of volunteers for the project in Hawaii. I would like to note who is attending this conference because I think there are some interesting perspectives. Certainly the university, private industry and the federal government are well represented, as are state governments - certainly the doers in this application. Noticeably, California does seem to have its share of participants. This is the second of two regional conferences. I think we had some comment from our eastern colleagues that it wasn't necessarily the program but the location of the conference.

In any case, we are pleased that these people were able to attend, and that we have representatives from each of the 14 states - either giving talks or on the panels. That way, we will get various perspectives. I think this provides us with a unique opportunity: communication and interchange among the state people. It has already been mentioned but I would like to re-emphasize it. We are seldom afforded the opportunity to gather state people together. Sometimes we discover how another state handles a problem from a technical and institutional point of view, how a technology is being adapted, and identification of basic problems.

Also pointed out was the sizable representation from the various legs of the community, the universities, private industry and other federal

agencies, and that this conference is being held in the West because of the land ownership situation in some states, particularly with regard to federal ownership. Federal agencies and land management aspects become an integral part of the states programs. We have attempted to incorporate them here wherever feasible. That is most successfully demonstrated by the early phases in the Alaska program.

Although the program encompasses a great deal more than just demonstration projects, we are in an activity phase in which most of the effort has already been conducted. I hope to give you some indication of where we are conducting demonstration projects.

May I call your attention to a couple of things. One is the Pacific Northwest. They started demonstration projects a few years ago. As far as NASA's role in demonstrating Landsat, we are not in that business relative to the Northwest. We are currently in a technical assistance role in getting them operational.

In other states there are sections in which we are working Landsat analysis in conjunction with state agencies, particularly California. Actually, even before the program, California looked like it had chicken pox if you drew charts representing all area sites compositely that universities and other programs used in test areas for Landsat applications and technology development. We are all in the business of trying to get that technology used.

All this indicates our extensive involvement. We initiated a program this year in Alaska with the very able assistance of Jim Anderson to orchestrate things up there. We are getting off to a good start. Considering the state's land mass, the local involvement due to the native claims act, and the exchange of property involved, Landsat may play a significant role in Alaska's future.

A portion of our program, because it focuses toward technology transfer, is not to find the problem by going back into the dark room, then solve it and deliver a product, but instead, to get state organizations involved in the process. This participation may mean committing staff to be trained and work with us on the project. They must learn the limitations and opportunities. They must travel to Ames and, as you all know, out-of-state travel requires a governors signature. It is not a trivial problem.

The Geographic Information System is probably one technology coming of age. More and more states either already have a GIS or it is in the resources planning and development phase. In some cases, this means dollars. If a state is trying to meet a legislative mandate and would like to run a demonstration project in a smaller or larger area than we can handle, the state needs to add money up-front to assist NASA and help expedite the process. In many cases that has happened.

Inside your conference folio there is a handout called "Current Cooperative State & Local Landsat Application Demonstration Projects," sponsored by WRAP and the ASVT Program. It is not my purpose here to try to give you an overview of what is going on technically in each state. What we have tried to provide is a summary of activities in each state, key them to the demonstration projects and then have poster boards out there to give you a better idea. Because we have a number of the NASA staff and state representatives here, I would encourage you acquire more information. More information exists, but this may give you a handle on finding out just what is available.

I would like, however, to briefly highlight two studies we are conducting to give you an inkling of the process. I have selected Montana and California. I chose California because we have a lot of Californians here and because there is a lot going on in remote sensing in the state. Therefore I wanted to show you what role we played in the program. Montana was selected because it contrasts California, and Tom Dundas is here. Montana is a good selection.

California is complex and large. Just to give you some idea, California's state budget alone is greater than the sum of the state budget's of all the other 13 western states combined. That translates to the size and magnitude of some agencies we are dealing with. Because of the size and complexity, we worked with the people in the state, the university and the agency personnel to try to develop an approach we could do something with in California with our limited resources. We assisted the Environmental Data Center in the formation of a Task Force to assist in applying our limited resources to California problems. Don Olmstead from ABAG currently serves as chairman of that group. You will hear more about that later. We also have an Industry Advisory Panel. I think it is going to integrate industry into follow-on and transition, including some realistic balance and opportunities that exist for follow-on work.

In attempting to establish what would be a significant accomplishment in California, we came up with the concept of vertical data integration. This term will be described later, but essentially it says how state, local and regional governments might access, share or use the same resource information collected in 1 geographical area.

Another important point is that, across the states, we have a number of disciplines and in any given study it is not just one discipline but several. This may represent one or a multiplicity of demonstration projects but we are trying to cover a range of applications.

To initiate the concept of vertical data integration, we started working with the California Division of Forestry to develop a statewide data base. This concept assisted in working and in solving one small part of the legislative mandate. But we wanted to work on this kind of data base, which has several levels to it, with an agency to see how much Landsat would assist in their problems. We also wished to determine the extent this sort of thing could be used on other projects. I am pleased to say that in this past year, the data base was used in every demonstration project. I think it serves as a setting point to the idea utilizing data and multiple levels of government. I won't talk any more about that except to say that it was completed and you will see more descriptive material.

In addition to CDF, we have other agriculture, regional and county projects in which there are different major participants. In the prime lands project, the major analysts is the university. In the county project, the major analyst will be private industry. In the regional project, the major participants will be a combination of Ames and the Association of Bay Area Governments. The CDF project will include Ames, Industry and the University, so we are trying to bring the complements of a team together in this project. There is another project going on in California which you will hear about involving the Department of Water Resources.

In Montana, they already had an existing form of GIS. There it was a question of how Landsat might be integrated into this Geographic Information System and how to develop a state capability. There were about 16 proposed demonstrations. These were narrowed down to 4, and we are now in the final stages. Software is being implemented in the state to carry out future activities.

Other states are covered in the pamphlets and poster boards and will be discussed further in the various sessions. I hope this conference provides a forum for information exchange where NASA takes a secondary role. I believe most of the speakers will carry out that theme. Thank you and if there are questions, NASA personnel will be available during this 3 day conference.

WESTERN REGIONAL REMOTE SENSING CONFERENCE

ATTENDANCE

	WESTERN STATES														OTHER		NASA AMES ATTENDEES	TOTAL
	ALASKA	ARIZONA	CALIFORNIA	COLORADO	HAWAII	IDAHO	MONTANA	NEVADA	NORTH DAKOTA	OREGON	SOUTH DAKOTA	UTAH	WASHINGTON	WYOMING	NON WRAP US	INTERNATIONAL		
STATE GOVERNMENT	4	4	10	5	2	2	2	1		1	1	2	3	1	1			39
REGIONAL GOVERNMENT			4	1						1			2					8
LOCAL GOVERNMENT	1		2															3
UNIVERSITY	2	3	37				2		1	5			6			1		57
PRIVATE INDUSTRY			61	1		1				3					9	2	14	91
FEDERAL GOVERNMENT			16	1			1	1		1	3	1		1	10		32	67
LEGISLATIVE				3						1								4
TOTAL	7	7	130	11	2	3	5	2	1	12	4	3	11	2	20	3	46	269

E REMOTE SENSING APPLICATIONS IN LAND USE/URBAN AREAS

PANEL CHAIRPERSON (Chief - Office of Geographic Research
Leonard Gaydos Western Mapping Center
Moffett Field, California)

THE TRANSFER OF REMOTE SENSING TECHNOLOGY TO STATE & LOCAL
GOVERNMENTS - THE NEED FOR A NEW APPROACH
Collin Fallat (Office of State Planning, Cheyenne, WY)

Mr. Chairman, fellow participants in the Western Regional Remote Sensing Conference. Thank you for the opportunity to address this important meeting. My involvement in remote sensing has evolved from an observer to an advocate in a state with limited involvement in this program. I base this current advocacy position on my experience in the State of Wyoming as a former Director of a State Land Use Planning Agency and currently as a Natural Resource Analyst in the Office of the Governor.

This morning's presentation is entitled "The Transfer of Remote Sensing Technology to State & Local Governments - The Need For A New Approach."

To clarify this title, which might be misleading, let me state that it is not my intent to evaluate efforts being made by NASA, the USGS, The National Conference of State Legislatures or other groups involved in transfer of remote sensing technology to state and local governments. Those involved in this effort are doing a professional job and I hope the level of effort not only continues, but increases in the future.

The area I will address is the problem of transferring remote sensing technology to state and regional governments who, for whatever reasons, have been reluctant or uninterested in using remote sensing technology as a tool in the decision-making process. It is this group that requires a new approach to technology transfer.

I will address two areas concerned with the transfer of remote sensing technology to previously non-participating groups. The areas are: user need evaluation and alternative approaches.

User Need Evaluation

To communicate the value of remote sensing to any interest group, one must be able to relate the technology to specific natural resource and land use management problems faced by that group. Presentations on how remote sensing was used to evaluate coastal margins or timber reserves will not be effective to an audience faced with extensive strip mining activity.

Therefore, I will relate how remote sensing technology could be used as a tool to assist management of major natural resource and land use problems existing in Wyoming.

Wyoming is a state rich in scenery, natural resources and western heritage. Wyoming, not unlike other western states, is rapidly becoming the energy pool of the nation.

The magnitude of Wyoming's Earth Resource Base is phenomenal. It is currently estimated that 53 billion tons of recoverable coal exist in Wyoming, and approximately 35 % of the nation's uranium reserve is located in the state. The only commercial trona deposits in the world are located in South Central Wyoming, with estimated reserves of 67 billion tons. In addition, the state has large oil shale reserves and bentonite deposits.

The effect of the energy boom is well documented in Wyoming.

Traditional agricultural uses of the land, mainly livestock grazing is being altered by mining.

Power plants and related energy industries compete with agriculture for limited water resources in the state.

Wyoming has experienced major population increases and concentrations. Impacted communities have rapidly changed from small agricultural oriented communities to boom towns. Addressing social, economic and land use conflicts from such rapid growth has, and continues to be, a major task facing both local and state government in Wyoming.

Current demands upon Wyoming's land, as well as other western states, is unprecedented in the nation's history. Wyoming is currently in a not enviable position of dealing with the natural resource and land use plans of the federal government and private industry on a daily basis. The state is attempting to accommodate natural resource demands while maintaining traditional agricultural and recreational uses. Utilization of remote sensing and related mapping would be helpful toward this goal.

Futhermore, specific areas exist where remote sensing technology could play an important role in resource and land management decisions in the State of Wyoming.

Mineral & Coal Leasing/OSM Unsuitability Criteria

Wyoming's involvement in mineral leasing and management decisions with The Bureau of Land Management and the Office of Surface Mining would be greatly strengthened if the state possessed full knowledge of established land use patterns, land productivity, sensitive environmental areas and other natural resources existing within any lease area. Application of remote sensing techniques to all lease areas could prove valuable in developing a natural resource/land use data base to assist in the decision-making process.

Proposed Forest Service & BLM Wilderness Areas

48 % of Wyoming is under Federal land ownership. Designating large tracts of this land as wilderness, currently underway by the Forest Service and The Bureau of Land Management, may have a major impact on the economy of the state.

Exclusion of some traditional land uses from such areas has the potential to alter the economic livelihood of many Wyoming citizens. In numerous areas, use of Federal lands have become the basis of a community's economy. Without an adequate knowledge of state land resources and private land use patterns, decision makers are placed at a disadvantage in negotiating boundary changes to exclude areas that are vital to the state's economic base. Utilization of remote sensing in establishing land use patterns and surface resources in such areas would be beneficial. Existing natural resources and land use patterns could benefit decision makers with the task of routing national trails.

Areas of Critical or More Than Local Concern

Designation of areas as being critical or more than local concern is an approach to land use planning now implemented by federal land management agencies, as well as some states. The 1974 Wyoming State Land Use Planning Act has a provision for establishing "areas of critical or more than local concern." Remote sensing technology should be reviewed as a possible tool in designating critical areas and inventorying surrounding areas as to their compatibility with such designations.

In summary, primary and secondary land use and natural resource changes brought about by rapid development of Wyoming's coal and mineral resources, combined with Federal land management decisions, is taxing the state's capability to adequately address and meet these changes. Decision makers, through laws, regulations and plans, are making major natural resource and land use management decisions without accurate and adequate information. Utilization of remote sensing technology may prove a valuable tool to those responsible for making such decisions.

Accordingly, remote sensing technology must be designed and presented to address specific needs of an interest group.

Alternative Approaches to Remote Sensing Technology Transfer

Approaches to transferring remote sensing technology are probably as varied, and, in some cases, as exciting as the technology potential itself. From a national and regional standpoint, the strength of remote sensing application is no stronger than it's weakest user. Certainly it is easier to work with organizations who are receptive to the technology than those who are not. Organizations responsible for technology transfer, however, must keep in mind that a major lag in application between states or regions can lead to problems should that state or region make the decision to implement remote sensing long after other states have done so. To avoid, or at least lessen the possibility of a major local technology lag, alternatives should be considered that will realize various levels of application nationwide.

The approaches I will briefly discuss are not revolutionary or all inclusive. Nonetheless, based on my experience, some are worthy of consideration.

Evaluation of the Power Structure

At the state level, basic recognition of remote sensing needs and implementation may come from 3 sources; a governor, the legislature or an agency head. It is unlikely all three will be equally enthusiastic or equally uninterested, but they should be initially consulted. Then, if a particular agency appears to be interested and capable of implementing a remote sensing effort, assistance and encouragement should be directed toward that agency. Yet the non-participants should not be ignored. Individuals in non-participating groups interested in remote sensing should be included as much as possible in the overall effort. Interested people from any organization can be effective over time in broadening the scope of remote sensing technology into their organizations. In summary, both agencies and key individuals within those agencies should be involved as a mechanism for transferring remote sensing technology.

Design of the Remote Sensing Program

We know it is easier to develop a packaged program than custom tailor a program to a specific situation. In Wyoming, packaged approaches to transferring remote sensing technology has not been effective in the dissemination and acceptance of remote sensing as a management tool.

It must be recognized that agencies within government have varying capabilities to integrate remote sensing technology into their operation. Program's that do not offer opportunities to implement remote sensing efforts through a series of steps and at a rate determined by the user will be rejected because of perceived inflexibility by the user. For example, LANDSAT technology evolved rapidly to the current use of computers in image interpretation and manipulation. Visual interpretation useage of LANDSAT as a mid-step in remote sensing application has been largely ignored by those involved in the technology. More consideration should be given to this area.

Private Organizations

Involvement of private organizations, many who are vitally interested and involved in natural resource and land use planning, should be considered as conduits of remote sensing information. Organizations, such as the League of Women Voters, plus state and national agricultural organizations, may serve as powerful messengers to their representative governments and could be quite effective in influencing favorable decisions on the implementation of remote sensing.

In closing, I will say that the potential of remote sensing is exciting and challenging and will possibly surpass even the expectations of individuals currently in the forefront of this science's research and development. We must not lose sight, however, of the challenge to apply this technology for solving ever increasing natural resource problems faced by our communities and states. This transfer does not involve electronics and optics - it involves communication and cooperation between people, all with different ideals and goals. To apply remote sensing technology at all levels of natural resources planning and management is a challenge that will indeed require new approaches.

USE OF LANDSAT DATA IN SPOKANE COUNTY - WASHINGTON
John Nunnery (Spokane County Planning Department)

Recognition of the need for and involvement of local government participation with the State of Washington's "Technology Transfer Program" to develop a state capability to process and utilize Landsat data is a primary necessity. Spokane County is only one agency dealing with planning activities that incorporate use of remote sensing data in conjunction with an overall statewide program.

Land use planning, lake entrophication, census applications, environmental impact and others rate high on the list of specific applications for Landsat data use.

To identify the correlation here, some background data on Spokane County is in order.

Spokane County is on Washington's eastern border adjacent to Idaho. The 36 mile east/west by 54) mile north/south area, comprise 1,763 square miles with topography ranging from the Cascade Mountains in the west, plains and prairies in the center, to the foothills and Rocky Mountains of the east. Surface character geology has been determined by volcanic Basalt Lava flows and the great flood during the ice age. Spokane/Rathdrum Prairie Aquifer is located in the glacial deposit-filled Spokane Valley running East/West across half of the valley.

Economically, service industries comprise the largest stable element of the counties 320,000 people. Land use is primarily wheat farming, timber, grazing and mining.

Politically, Spokane County has many solid citizens of conservative interest. While they recognize the need for free enterprise, the north-west's inherent aesthetic lifestyle brings real concern for levy of taxes and the use of that revenue.

Several factors contribute to future planning of Landsat uses and the continued participation of local government support. First, money is not always readily abundant. Second, availability of government leadership to continue program direction and third, education of the public and legislators is essential to garner support and funding.

Future planning activities for Spokane County concern water facilities, waste water, aquifer resources. Current uses of Landsat data for projects include: countywide land cover for a Comprehensive Land Use Plan, establishment of a data base to meet a 1976 Environmental Ordinance and for Spokane International Airport planning.

To date, work has been identified by 203 base classes aggregated into a 20 classification scheme in 4 disciplines: agriculture, timber, range and urban.

Various output products are used in planning applications such as, public hearings, zoning, subdivision planning and public and legislative education.

In summary, Spokane County has been involved in a 3 year effort using Landsat data and is close to an operational system. Like NASA and PNRC, "time" is needed to promote the "Technology Transfer Program". As a local government, we need "time" to orient and train the public and politicians in Landsat data use to make this program a continued success.

In effect, Spokane County could lose what we call the "Landsat Battle" if we are not given the necessary help and time to complete an operational and understood system.

TACOMA'S USES OF LANDSAT DATA - WASHINGTON

Nancy Grabinski-Young (Urban Planner - Tacoma Planning Department
Tacoma, Washington)

The City of Tacoma's Planning Department used or attempted to use Landsat data products as follows:

Vegetated Area Identification - Classification & Measurement

- Landsat lineprinter maps provided the Planning Department with vegetation data unavailable from any other source. Specifically, the Landsat vegetation data was coded into a grid cell format for input into a GIMS system (Geographic Information Management System). This system interrelates various layers of computer coded data such as vegetation, topography, population and land use.

The second area where this type of data was used involved an Environmental Impact Statement for a sparsely populated area of the city. Landsat provided the areas only vegetation data which otherwise would have to be gathered by a costly field check.

Development Intensity Area Delineation & Measurement

- The Planning Department is developing a future development map of the city to direct future growth. Instead of limiting future development to specific allowed land uses, the city adopted a policy to allow areas of development intensity. Development intensity of a project is basically determined by size, scale, nuisance level, open space and traffic generation. Landsat was used by the Planning Department to provide a check on the present contents of each intensity area. Intensity boundaries were overlaid with the Landsat image and the resultant image proved that the intensity areas were consistent with the present land cover of the area.

Special Districts - Content Identification & Measurement

- A number of special districts such as police reporting districts, health districts, planning areas, legislative districts, census areas and zip code areas were originally digitized to demonstrate JPL's IBIS (Image Based Information System). This system interrelates different boundaries for comparison and summarization. But as a bonus, these districts were registered to the Landsat image and summaries of Landsat data were obtained by each of

these districts. Due to Landsat's present resolution, these summaries only provided a general idea of each district's land use/land cover. It provided however, land use information by districts that were never available before for example, land use by geological areas.

Vicinity Development Map

- Many committees and organizations utilized Landsat Dicomed products to represent the city's general urban form. The image provided a general land use/land cover map of the city and its surrounding areas. It filled a use that cannot be achieved with manually created land use maps nor aerial photography. Classified images should not be underrated as a unique tool in themselves.

Rainfall Runoff Tabulations

- Our Public Works Department attempted to use acreages of Landsat classes to predict the amount of rainfall that would run off into each drainage basin. This was to be accomplished by looking at each classification and determining the amount of runoff produced and then calculating total runoff for each drainage basin. This project was not completed but it is mentioned as an idea to others.

ANTICIPATED USES

LUMIS Display of Landsat Data

- Tacoma received from JPL their Land Use Management Information System (LUMIS) which, among other things, can display Landsat data by Census Tracts. Presently, we are transferring LUMIS to our city's computer, an IBM 370-158. At this time we have not seen Landsat data displayed on LUMIS but we anticipate the projects completion within the next year.

Change Detection

- If change detection can be successfully demonstrated for Tacoma, we envision a number of uses for maps and tabulations of this data. Generally, the data is not as detailed as we would prefer, but it gives us an estimate of where and how much land use change is taking place. Thus, it allows us to concentrate our detailed study to these areas.

Geographic Base System & Landsat Data

- Tacoma is developing a computerized GBS and views Landsat data as one of this system's many structures.

CONCLUSION

Tacoma solved data problems by utilizing Landsat data. We feel that as technology associated with Landsat improves, we will discover more data applications.

Ronald H. Smith (Arizona Game & Fish Department
Phoenix, Arizona)

Three Bar Wildlife Area, as well as contiguous areas to the north and west, make up the approximately 120 square mile test site. This area lies about 60 airline miles east of Phoenix and roughly parallels the north-south orientation of the Mazatzal Mountains. It was chosen because of the background of intensive wildlife studies being conducted there and because of the detailed vegetation classification being completed concurrently by the University of Arizona under contract with the Game & Fish Department. This latter classification based mainly on the photo-interpretation of CIR, plus an extensive knowledge of the area, is providing Game & Fish personnel with a solid information base they can use to judge final Landsat classification.

Interior Chaparral covers about one third of the area comprising 20-30 shrub species. These are broad-leaved evergreens quite similar in form to the coastal chaparral. They are generally deep rooted and sprout vigorously after fire.

Riparian gallery forests, woodlands and coniferous forests comprise the rest of the area.

We visited about 80 field training sites including 22 vegetation classes. At least 3-4 sites were selected for each vegetation type. The areas vegetative diversity and many discontinuities made it difficult to find large homogeneous blocks of 40 acres or larger. These sites were outlined on mylar overlays for orthophoto quads at a scale of 1:24,000.

The first computer output was in the form of a symbolic line printer map consisting of 47 clusters. This clustering process was based first on an unsupervised classification of all pixels within test site area. Statistics for the supervised classification were then merged with the unsupervised. In effect, the supervised classification's 4 dimensional clusters were overlaid on the unsupervised. Where a conflict between the two existed, supervised classification was selected.

Concentration ellipses were plotted two dimensionally for Bands 5 and 6 and Bands 4 and 7. Performance of the clustering algorithm can be seen from the graphical overlay of major vegetative classes on the two dimensional ellipse plots. Classification worked better in 4 dimensional space than it did in two.

In preparation for a field trip to the test site, groups of like classed pixels were outlined on the original 47 cluster LP map. These small area outlines were transcribed to orthophoto and topographic quads. Registration of LP maps and topo maps was accomplished by using recognizable features such as lake shores and training sites. Sets of LP, orthophoto and topo maps were taken to the field. We attempted to verify classification by pinpricking through from LP to topo map. It became obvious very quickly that registration of the map sets posed a problem. Because of the precipitous terrain of Three Bar, there are many discontinuities in the vegetation (north/south aspects, stream channels). As a result, areas of like classed pixels which we chose to inspect in the field were relatively small (less than 25 pixels), and precise registration of pixel data onto maps was particularly important to enable locating them in the field. Lacking precise registration, we were unsure of the classification we gave to some small pixel groups. Because of our dissatisfaction with registration, we will make another field trip in November to the test site. We hope to use gray scale maps to assist in the process of finding specific pixel groups on the ground. Gray scale maps, based on original Landsat data, are more reflective of topographic features. They can also be matched pixel for pixel, with the LP maps and offer a way to bridge the registration gap between LP map and orthophoto.

LP classification map performance is difficult to judge at this stage. Classification of the dense chaparral and forested areas was generally

good. The process did not delineate the single most important vegetation type on the area - the riparian gallery forests. These linear features are important to wildlife out of proportion to the small relative area they occupy.

F STATE TASK FORCE CONCEPTS

PANEL CHAIRPERSON (Chairman - PNW Technology Transfer Task Force
Wallace E. Hedrick Resources Northwest, Inc.
Boise, Idaho)

ALASKA LAND MANAGERS TASK FORCE

J. Anderson (Chief Coordinator/Planner - Department of
 Natural Resources
 Anchorage, Alaska)

The state has already recognized remote sensing's essential role in meeting its mandated requirements in creating an institutional mechanism for technology transfer and in addition, operational capabilities development. Alaska's Land Managers Cooperative Task Force, established by memorandum of agreement between the Governor of Alaska, the Secretaries of Interior & Agriculture and the Alaska Federation of Natives, provides a vehicle for cooperative efforts at solving Alaska's land planning problems. It inherits a tradition of Federal-State cooperation fostered by the interim Federal-State Land Use Planning Commission for Alaska. This Commission was established by Congress as a part of the Alaska Native Claims Settlement Act of 1971. It terminated operation this summer.

Alaska's Land Managers Cooperative Task Force agreed to promote coordinated land planning and cooperative resource management in the state. Objectives of Alaska's Land Managers Cooperative Task Force are:

- To identify general concerns deserving cooperative efforts and principles for developing specific cooperative agreements.
- To identify specific geographic areas requiring early cooperative planning and management.
- To initiate and facilitate development of specific cooperative agreements and projects.
- To identify groups and agencies with planning authorities or resources that can aid the land managers and to involve these groups and agencies in an advisory capacity to identify existing cooperative planning mechanisms and to recommend their use or modification.
- To serve as a focal point for involvement of the land managers with planning efforts of other groups.

An executive committee consisting of the Alaska-based designees of the Secretary of the Interior, the Secretary of Agriculture, the Governor of Alaska and President of the Alaska Federation of Natives, heads the Task Force.

The Task Force's committee on Natural Resource Information Management (CONRIM) is a group of agency managers and technical specialists organized to bring the best available knowledge about data collection and analysis techniques to bear on identified problems. Its work includes surveys of existing resource data and a statewide data needs assessment.

Alaska's Remote Sensing Task Force, established initially under the Land Use Planning Commission and now permanently constituted as a subcommittee of CONRIM, is charged with:

- 1 Advising the state on appropriate application of remote sensing technology
- 2 Relating findings of the statewide data needs assessment to potential remote sensing applications
- 3 Promoting information exchange
- 4 Sponsoring training activities
- 5 Sponsoring & coordinating cooperative demonstrations
- 6 Developing recommendations for the design and implementation of operational capabilities

Among its activities, the Remote Sensing Task Force sponsored the Alaska Cooperative High Altitude Aerial Photography Program (supported jointly by ARC and JSC), which as one of its key objectives, provides an initial set of statewide surface data supporting a satellite remote sensing program.

TASK FORCE CONCEPTS

Mary L. Arbogast

(Task Force Coordinator - California Integrated
Remote Sensing System
California Environmental Data Center
Sacramento, California)

In January of 1979, NASA and the State of California established the California Integrated Remote Sensing System or CIRSS. CIRSS is designed to demonstrate the feasibility of using remote sensing in the data collection and management activities of California's government agencies. Funded as an ASVT project through NASA Ames, CIRSS' key concept is vertical data integration or the sharing of data from one level of government upward or downward to another level or levels of government. Technical aspects of CIRSS and its individual projects will be discussed in greater detail in a later session.

CIRSS is managed and guided by a Task Force unique in its composition. It was felt that, to fully evaluate the project, all sectors involved in remote sensing in the state should be involved. The CIRSS Task Force consists of 2 local government representatives (county planning director, county supervisor), 2 state agency representatives (Energy Commission, Department of Food & Agriculture), 1 regional government representative (Association of Bay Area Governments), 1 legislator (California State Assembly), 1 representative of the Governor's Environmental Data Center, 2 academic representatives (University of California system, state universities and colleges), 1 NASA representative and 1 private industry representative. Having met 4 times to date, the Task Force convenes approximately every 2 months.

The responsibilities of the CIRSS Task Force are:

- Evaluate and review the demonstration projects based on available information and specific evaluation criteria (currently being developed). (Possible review categories for evaluation include technical objectives and review, organization/work plan, project progress, communication and user requirements.)
- May recommend changes in the scope or direction of the demonstration projects.
- Responsible for the communication aspects of the project (such as newsletter articles, mailings from each member to the groups they represent, and future publications).
- Assist in the preparation of follow-on CIRSS work plans (i.e., 1980 - 81).

The Task Force felt that, due to the vast size of California's private remote sensing industry, one representative was insufficient and therefore established the CIRSS Industry Advisory Panel to work with the Task Force. The panel is responsible for evaluation of individual projects from the private sector perspective and for setting up a communication network within the private community. Their first project has been the development of a California remote sensing private industry directory. Constructed to allow continuous updating, the directory has been reviewed by the Task Force and, following suggested alterations, will be published within the next few months.

CIRSS has proven to be a unique and interesting experience for everyone involved. It is the first strong step in bringing a vast and previously fragmented remote sensing community in the State of California together. Each Task Force member must bring with them to the main body, the perspective of the group they represent while simultaneously reviewing the project from the perspective of the group as a whole.

NATURAL RESOURCES, REMOTE SENSING & CARTOGRAPHIC TASK FORCE
Thomas Dundas (Department of Community Affairs
 Helena, Montana)

"Time" is the key element to the transfer of technology within the states. After 3 years of diligent effort, we are on the verge of a fully operational system using Landsat and ancillary data.

Organizationally, we are with the Department of Community Affairs. Our department however, is called the Research & Information Systems Division because we are the primary research and statistical data gathering and analyses group for the State of Montana. Designated as the state data center, all economic, population and statistical data is correlated and analyzed for socio-economic trends.

Historically, we began work with the US Geological Survey in the early 70's using 1:250,000 scale maps to assimilate a raw data base. Information concerning parks, forests, townships, legal descriptions etc., were incorporated into the data base.

In 1972 and 1973 we evaluated entering manual Landsat data through USGS and EROS into the system but it proved not feasible. In 1977, NASA provided a workable approach to combining data more efficiently. Subsequently, the "Montana Geodata System" was formed and new types of information added to the data base. New information included water and air quality statistics, land ownership and subsurface mineral ownership rights. In conjunction with NASA, we developed several types of demonstration projects and selected 4 from the 16 proposals submitted. Others will more fully define these during later sessions.

Basic problems which the Task Force faces focus on communications. First, difficulties arise because department heads are political appointees who are not always close to the technologies involved with their department. Second, vertical integration of departments through which information and communications is supposed to flow, often is lacking. This gap needs to be bridged to fully integrate a cycle of communications dissemination with appropriate feedback. In addition, federal agencies are not fully organized which complicates the coordination of activities between state and federal agencies.

Regardless of some communications difficulties, we are pleased with NASA assistance and their sincere help and sensitivity to our problems.

We are beginning to set up a Remote Sensing & Cartographic Task Force to identify areas of similarity and mutual benefit to bring the departments within the state closer together.

In summation, it is going to take time to integrate the capability of technology into the goals of the departments, thus, federal agencies must have patience with the states. In our case, it may take years to identify specific applications in an operational sense. Similarly, it is going to take time before the technology is transferred to the states and becomes fully operational. And finally, it takes time to appropriate the required funds for these projects.

Thus, reiterating my opening remarks, "Time" is the key element to the transfer of technology within the states.

TASK FORCE FUNCTIONS IN THE PACIFIC NORTHWEST
Alan Porter (Bureau of Natural Resources
 Boise, Idaho)

The Pacific Northwest Regional Commission is financially supported by the US Department of Commerce for the purpose of initiating, coordinating and implementing regional programs to improve the economic conditions in the region. An important part of the Northwest's economic base are extractive industries such as agriculture, forest and mineral resources.

Effective planning and management of these natural resources and concern for the region's environmental quality, led to the decision to examine and use Landsat capabilities and other remote sensing technologies to generate timely land cover information for improved planning and management.

The Technology Transfer Task Force consists of a representative from each state, NASA Ames, USGS/EROS and a project coordinator. Involvement in varying degrees of approximately 45 user agencies in Washington, Oregon and Idaho, required a great deal of time and support by all organizations involved. Support in the form of training and technical assistance was provided by NASA Ames, USGS (EROS & Geography), private contractor (ESL) and universities in the Northwest and California. The idea was that all the demonstration projects would be user driven.

The Task Force was responsible for preparing recommendations to PNRC concerning Landsat data analysis process. Several studies were sponsored to address the issues. Resulting recommendations led to the current PNRC related project known as the Landsat Application Program. LAP is attempting to transfer to the 3 states, the operational capability for performing digital analysis of Landsat data on state computers. Instead of one regional center to provide this analysis capability, each state is operating independently relative to their individual capabilities. In Idaho, the Department of Water Resources has taken the lead responsibility to establish software and hardware image analysis systems. DWR is working with small cadre of trained personnel, limited funds, no computer service center support, but with the strong support of the Governor and the DWR Director.

The Task Force has probably not been overly introspective in examining how it actually functions, other than it wants to expedite the process of transferring this particular technology. Introspection has been provided, however, in a clarified manner by Dr. Hoos of the University

of California. The Task Force's working relationship can be defined in terms of its role being essentially one of management, coordination and grantsmanship. More specifically, the Task Force attempts to function as supporters, crisis solvers and promoters of the technology. It also attempts to provide needed political interface and also act as intermediators between users and transferors of the technology.

Ongoing development of operational Landsat analysis capability in LAP with less technical support by Federal entities might be considered more of a real world situation. Unfortunately, institutional constraints to developing the technology in the Northwest seem to be growing at an exponential rate. Institutional constraints are more than resistance to technological change. It appears to be a larger question of whether government can function efficiently or rationally. Despite serious constraints, Idaho may be close to achieving the critical mass necessary for establishing a productive Landsat analysis capability.

THE TASK FORCE EXPERIENCE

Leonard Slosky (Office of the Governor
 Denver, Colorado)

For the past several years, Colorado has had 2 subcommittees of the State Mapping Advisory Committee which serves to coordinate the development of a state Geographic Information System (GIS) and assess the utility of Landsat to Colorado's data needs. These two interagency coordinating subcommittees have recently been abolished. The Governor is committed to the systematic and coordinated assessment of Landsat's capabilities.

In addition, the Governor is convinced that development of a state GIS can not proceed without adequate interagency coordination. Therefore, in the near future, the Governor will reestablish an interagency coordination mechanism to oversee the development of the state GIS and the assessment of Landsat.

In 1972, Texas initiated development of the Texas Natural Resource Information System (TNRIS). TNRIS is a cooperative effort among 13 natural resource related agencies. Procedural direction is provided by a Task Force composed of 1 member from each of the participating agencies. The TNRIS Task Force has established the Remote Sensing & Cartographic Committee to provide guidance in the specialized area of remote sensing. Most TNRIS Landsat activities are initiated by member agencies. Member agencies have varying degrees of Landsat analysis capabilities. Requests for assistance requiring considerable staff or computer time are conducted as joint projects between TNRIS and the requesting agency. TNRIS is housed within the Texas Department of Water Resources. TNRIS Systems Central Staff, consists of 15 full time employees, three are devoted entirely to remote sensing. Primary funding for TNRIS is from the state's general revenue.

In fiscal year 1979, the budget for TNRIS is about \$ 600,000.

SESSION II

17 OCTOBER 79 WEDNESDAY (PM)

WESTERN REGIONAL REMOTE SENSING CONFERENCE
CONVENED AT
THE NAVAL POST GRADUATE SCHOOL
KING HALL
MONTEREY, CALIFORNIA

SPONSORED BY NASA AMES RESEARCH CENTER
MOFFETT FIELD, CALIFORNIA

A REMOTE SENSING APPLICATIONS IN AGRICULTURE

PANEL CHAIRPERSON (Idaho Department of Water Resources
Kim Johnson Boise, Idaho)

Throughout the Western US, state and local users have expressed considerable interest in applying remote sensing technology to agriculture. Agriculture, currently and historically, is a major economic activity in the Western United States and a major resource consumer. Resources used in agriculture include land, water and energy, all in great demand by our economy and society. Therefore, responsible resource policy decision requires accurate, timely support information concerning agriculture. Agriculture is dynamic, characterized by constant changes in cropping practices, land utilization and other resource demands. In addition, agriculture is distributed over extremely large areas and in obtaining information about such widely distributed and dynamic resource can be difficult.

Remote sensing, especially the synoptic view and repetitive coverage characteristics of Landsat, has been recognized as a means of overcoming limitations in collecting statewide agriculture information. Papers presented here represent current activities by western state agencies to utilize remote sensing and, in particular, Landsat for obtaining agriculture information.

A wide range of methodologies concerning the application of Landsat will be discussed. All the applications, however, are based upon similar information requirements, or a lack of existing information, and the fact that remote sensing technology utilizing Landsat can be an effective means of acquiring needed agricultural resources information.

LANDSAT ANALYSIS FOR MONTANA DEMONSTRATION PROJECTS
George Cawlfild (Department of Natural Resources &
Conservation
Helena, Montana

Montana initiated 4 demonstration projects as follows:

- 1 Delineate Water Bodies for the purpose of identifying locations and sizes of existing dams/reservoirs for dam safety purposes and monitoring of new dams/reservoirs for dam safety and water rights permitting procedures.
- 2 Identify land use in Cascade County as an aid to county and local planning.
- 3 Inventory agricultural croplands for determinations or irrigated and non-irrigated lands, crop types, range conditions and tax assessment classification purposes.
- 4 Inventory forest land for forest inventory, insect/disease infestation, change monitoring and tax assessment classification.

Two adjacent complete N-S scenes, centered on Great Falls and Three Forks Mountain for 26 July 1976 with minimal cloud cover were chosen for the demonstration projects.

The initial effort on the first project apparently produced excellent results. Nevertheless, results of the third project appeared to satisfy the first project more satisfactorily.

The second demonstration project produced results which can be used for public relations, education and as a general planning tool, but Cascade County feels more detail is needed to make adequate land use decisions.

The third demonstration project for agriculture resulted in the following 14 classes.

Water	Irrigated Cashcrop (Potatoes/Sugar Beet)
Shadow	Dryland Crop
Irrigated Hay	Trees
Clouds	Barren
Irrigated Grass/Grain	Range
Fallow	Sparse Range
Wet Range	Brush

These classes will probably be adequate to estimate water use for the irrigated classes. More information is needed for other uses such as classification for revenue assessment.

The fourth demonstration project on forestry never really got started due to lack of funds and personnel.

If adequate resources in terms of travel dollars and personnel time had been available, we probably would have been able to obtain better results by:

- 1 More care and accuracy in training site selection.
- 2 Distributed the training sites more evenly over the scenes worked with.
- 3 Performed some initial stratification by such things as climate zones and elevation.

In the future, we hope to perform an accuracy analysis and some further work with the demonstration projects to see if we can better satisfy our requirements. We are working on obtaining funds for these efforts and will use VICAR/IBIS which has been installed in Montana.

Government agencies need a fast, efficient and economical method for inventoring natural resource data and change monitoring. Current manual methods are too expensive and time consuming. Landsat or some remote sensing capability along with new techniques and improved technology will enable us to do our job better, if not today, sometime in the future.

THE OREGON WATER RESOURCES STATEWIDE LAND USE INVENTORY
Madeline Hall (ERSAL - Oregon State University
Corvallis, Oregon)

Since October 1978, the Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis (ERSAL) has been involved in a 2½ year project inventorying land use throughout the State of Oregon. This work was undertaken for the Oregon Water Resources Department (OWRD) as one step in a procedure to determine present water use and future water needs in the state which will assist the Oregon Water Policy Review Board in formulating future policies.

Hi-flight color infrared aerial photography at a scale of 1:130,000 is used to delineate to a 10 acre minimum land cover types: irrigated agriculture, non-irrigated agriculture, rangeland, forest land, urban, water and others. These land cover types are equated with land use types. Collateral data aid interpretation of questionable sites. Aerial photography provides necessary spatial detail, but varies in date of acquisition from 1972 to 1978 and from April to September. Current activities are detected using Landsat data. Delineations are updated using three bands (4, 5 & 7) false color composite transparencies at a scale of 1:1,000,000.

After updating to the present growing season (1978 or 1979) is completed, the delineations are transferred onto stable base maps (USGS 1:24,000 or 1:62,500 topographic maps or 1:24,000 orthophotoquads). Transferring is accomplished by three months depending on the type of map, the number of landmarks and the complexity of delineations being transferred. A zoom transfer scope is used when transferring complex delineations to 1:24,000 or 1:62,500 scale maps. An overhead projector is used to transfer data to 1:24,000 scale maps with few landmarks and widely spaced delineations. Large format lantern slides are used to transfer data to 1:62,500 scale maps where few landmarks are available and delineations are widely spaced.

Land cover class interpretation delineations are edited after updating is complete. An additional editing phase follows transfer of data to base maps. Map boundary ties and legend symbols are scrutinized. At this point, the work is turned over to OWRD where delineations are cross checked with water rights maps. Accuracy of irrigated land identification has been greater than 95 %. OWRD then proceeds with polygon area measurement, tabulates the data and produces final base maps at variable scales (1:60,000 to 1:200,000 depending on the size of the basin).

ERSAL is developing training and interpretation aids for use by OWRD in future updates. Two hundred predetermined field sites were visited at three intervals during the 1979 growing season. Ground photographs were taken to show changes of ground condition during the season. These will be correlated with low-flight and hi-flight photography and Landsat imagery for use as training aids during the present project and interpretation aids for future basin updates.

IDENTIFICATION OF CRITICAL AGRICULTURAL LANDS OF COLORADO
James Rubingh (Department of Agriculture
 Denver, Colorado)

Colorado's Department of Agriculture began a study of agricultural lands conversion in July 1977. This study's purpose is to determine trends of agricultural lands conversion occurring in Colorado, consequences which resulted from this conversion, the dynamics behind it, and possible responses to such conversion. To discern the magnitude and types of conversion pressure upon agricultural lands, critical agricultural lands of the state are being identified. Critical agricultural lands are defined as follows:

- 1 High agricultural production potential
- 2 Currently or potentially in agricultural use
- 3 Under present or potential conversion pressure from
 urbanization, energy development and similar activities

To delineate critical areas, a computer mapping system (CMS-II) was employed. Use of this tool allowed compositing of conventional maps containing soils, remotely sensed information, energy resources and other pertinent data. The composite strategy used provides that identification of significant croplands requires that various agricultural activities (i.e., irrigated cropland, dry cropland, rangeland) be located. Available maps were somewhat outdated (Circa 1973) and were either too general or at an improper scale for our use (1:500,000 was required).

The land cover use data source desired had to meet the following requirements: 1,500,000 scale, have Level 1 accuracy, be capable of distinguishing various agricultural activities, current, updating capability and inexpensive. Optical interpretation of Landsat imagery met each of these criteria and the first Landsat mosaic of Colorado was developed in the summer of 1977 at Colorado State University.

Three mosaics were developed for the years 1973, 1976 and 1977. The 1976 mosaic was built first. Prints at 1:500,000 scale were purchased from USDA and spliced together. Registration was done using a hand-drawn acetate overlay of the drainages within the state. Mosaics for 1973 and 1977 were developed by first obtaining 1:1,000,000 transparencies and having the prints processed at 1:500,000 at Colorado State University.

Registration for these mosaics was achieved by using a USGS clear acetate map of Colorado at 1:500,000 scale. This method proved far superior to the technique used for the 1976 mosaic.

The next step was the development of a classification scheme. The land use/cover scheme used is based upon Anderson's Level I classification scheme. Level II and III categories were added for the agricultural categories. In total, 17 land cover/use categories were identified on the mosaics. The 8 agricultural categories included: irrigated cropland, center pivot irrigated cropland, mountain hay fields, non-irrigated cropland, mixed cropland, high biomass rangeland, medium biomass rangeland, and low biomass rangeland. Other categories included: coniferous forests, deciduous forests, mixed forests, barren land, alpine, water, urban, snow and clouds.

Classification was done optically on a cellular blanket. Each cell measured 1/8 inch by 1/10 inch and corresponded to approximately 500 acres of land area. For each mosaic, some 132,000 cells required classification.

With completion of the mosaic classifications and conversion pressure maps (e.g., energy resources and energy activities), critical areas could now be identified. Areas of potential conflict between agricultural land uses and resources and energy activities were identified. Other questions dealing with urban growth on agricultural land could be answered by compositing the 1973 land cover mosaic with the 1977 mosaic. One future use of the mosaic will be to combine the 1977 mosaic with a surface area water map to determine Colorado's irrigated cropland percentage dependent upon nonrenewable water sources.

Use of these Landsat optical products has proven quite beneficial in the identification of critical areas at a small scale level. Certain problems have, however, been identified which detract from the accuracy of these mosaic interpretations.

Two problems encountered involve the quality of the imagery obtained. Average geometric distortion was found to vary between 2.0 mm on the 1976 mosaic to 0.6 mm on the 1977 mosaic. (The 1977 mosaic was used in the identification of critical areas.) Color balance also posed a problem in development of prints used in the mosaic. Because tone (color), geometric pattern and texture are the basis of optical interpretation, problems in color balance can cover significant problems for interpreters.

In selecting the imagery, close attention should be paid to cloud cover. Even light cloud cover may cause problems since it tends to distort colors. Phenological changes must also be considered when agricultural land interpretation is carried out. Various crops mature at different times and it is unlikely single data imagery can be used to locate all irrigated land.

In addition, interpreters had difficulty in optically locating small cities (less than 20,000 pop.) and fringe areas of larger metropolitan areas. Ancillary maps helped resolve this problem.

Despite these problems, many benefits have been derived from optical interpretation of Landsat imagery. Cost was extremely low when compared with other possible procedures for determining land cover. For the 3 mosaics, it is estimated to have cost as little as 2.5¢ per sq. mile. Level of accuracy, scale and other features are highly compatible with other data sources used in this study. It is also possible to update land cover yearly and to develop a historical record land cover changes within Colorado.

Certain recommendations evolved from this study. First, improvements in color balance and scale control are needed and are presently being developed by NASA. Secondly, multirate imagery should be used to interpret the extent of irrigated cropland. Finally, ground truthing should be included to the extent possible whenever optical interpretation is being conducted. Without it, interpreters are working in a vacuum and have no way of knowing what accuracy they are achieving.

In summary, we learned a great deal concerning optical interpretation of Landsat imagery. Future efforts will benefit greatly from these efforts. It must be remembered this was used as a "red flag" procedure only, not for detailed analyses. This procedure shows where major changes and conflicts occur and where a closer look using aerial photography and other data is required. Finally, a historical record has been initiated and an examination of changes over time can now be carried out.

CALIFORNIA IRRIGATED LANDS ASSESSMENT FOR WATER MANAGEMENT
Glenn Sawyer (Department of Water Resources
 Sacramento, California)

California has approximately 9.3 million acres of irrigated land. Water management studies and activities of the State's Department of Water Resources require a continually updated file of water using land use information. In the interest of finding less expensive procedures than currently used, for acquiring necessary data, DWR joined with NASA and researchers at the University of California at Berkeley and at Santa Barbara in a 5 year, 4 Phase Study. They will investigate possible applications of satellite imagery-related techniques to assist in land use surveying.

The 4 phases are defined as follows:

- 1 Total irrigated area estimation based primarily on photointerpretation.
- 2 Total irrigated area estimation assisted by machine processing digital data.
- 3 Specific crop acreage estimation through photointerpretation.
- 4 Specific crop acreage estimation assisted by machine processing of digital data.

Work is proceeding on all phases concurrently. A major effort, however, currently is on Phase 1. The general approach following initial work on techniques is to test the techniques first on a limited area (such as one 7½ minute quadrangle area), then on a large regional area and finally if the procedures appear feasible on a statewide operational basis.

Phase 1 is in the last test stage with an objective this year of verifying feasibility and cost of using photointerpretation techniques to derive estimates of irrigation area statewide. Phase 2 work is at the regional test stage and Phases 3 and 4 are in the initial stages of technique development.

We think both techniques for irrigated area assessment will be perfected to the point that they will be acceptable for operational use. Which of the 2 methods we adopt depends upon relative costs, equipment requirements and skills required. Techniques for estimating specific crop acreages require considerably more perfection and testing, before their applicability to our needs can be determined.

LANDSAT DIGITAL DATA ANALYSIS FOR IRRIGATED CROPLAND INVENTORY
Kim A. Johnson (Department of Water Resources
 Boise, Idaho)

Idaho's Department of Water Resources is participating in the Pacific Northwest Regional Commission's Landsat Technology Applications Project. Two major activities are being addressed by IDWR. The first activity is development of a Landsat Digital Data Analysis capability for Idaho. This is being accomplished by installation and operation of Jet Propulsion Laboratory's VICAR-IBIS software on the state computer system. The second activity is the development of operational Landsat multispectral classification procedures for inventorying irrigated cropland. Analysis activity objective is to produce consistent multispectral classification results utilizing the VICAR-IBIS software on the Idaho computer.

Landsat image and digital data from 9 August 1977, Scene E-2930-17122 was used. Data analysis was conducted for a single test area in the Upper Snake River Basin of Southeastern Idaho. The 3,900 square mile test area was selected because it contained highly diverse wildland conditions and irrigated agricultural practices. Stratification, based upon interpretation of a 1:250,000 color composite image, was accomplished to identify areas of similar ground cover/reflectance characteristics. The stratification process identified 12 irrigated agricultural strata, 2 dryland farming strata, 3 rangeland strata, 1 basalt (lava) flow stratum, 1 upland stratum and 1 urban stratum.

Ground data collection was controlled by a stratified random sample. The number of samples for each stratum was proportional to the stratum size. A sample unit size of 2.5 km by 2.5 km based upon the Universal Transverse Mercator grid system was used. Using high altitude aerial photography, agricultural fields within each sample unit were delineated on USGS topographic maps. Ground data consisting of crop type, irrigation method and crop conditioning were obtained on a field by field basis.

Cluster statistics were developed based upon the "Modified Cluster Technique" defined at LARS-Purdue (Flemming, Berkebile and Hoffer 1977). Our procedure consisted of selecting 16 training sites varying in size from 1,500 to 7,000 pixels, distributed throughout the test area. Each training site contained a limited number of general ground cover conditions present in the test area. The total combination of training sites was representative of the overall test area. Each training site did contain photo/ground sample unit data. Landsat data for each training site was independently clustered, using an unsupervised guided clustering algorithm. Following the clustering, each training site was classified and a line printer map of the site was produced.

Cluster classes were identified by registering the training site classification output to sample unit maps and aerial photography using a Zoom Transferscope. This procedure, especially use of aerial photography, allowed us to do a relatively detailed identification of cluster classes within the training sites. A class identifier was assigned to each cluster. In those cases where clusters defined multiple cover types, all cover classes for the clusters were recorded along with the appropriate stratum identifier.

Once clustering and class identification was completed, cluster statistics for all training sites were combined into a single statistics file. Conflicting clusters were identified based upon their Swain-Fu separability. The combined statistics file was edited so that all but one of any group of conflicting spectral clusters were eliminated. When conflicting clusters (poorly separable) represented different major ground cover classes, multiple classes and their associated stratum/strata were recorded. Various versions of the edited statistic file were used to reclassify training sites for evaluation purposes. The iterative editing process was continued until a final "master statistics" file was developed. The resulting "master statistics file" contained 62 spectral clusters which applied to the entire test area.

Using the master statistics file, a maximum likelihood classification was done for the full test area. Following classification, the cluster/classes previously identified as representing multiple cover conditions were assigned new unique identifiers according to their occurrence within the test area strata.

Detailed evaluation of the classification has not been completed. Initial qualitative and quantitative review of the classification results is favorable.

Identification of irrigated cropland has been evaluated by comparison of the sample unit photo/ground data and the Landsat classification results for one irrigation stratum. The comparison is favorable with correlation coefficient of .968. Such classification results are compatible for operational use by IDWR.

Application of image stratification and the "Modified Clustering Technique" in conjunction with the VICAR-IBIS software, will support operational applications of Landsat digital data by IDWR. Stratification is well suited for use with VICAR-IBIS since the system does effectively handle ancillary geographical data in conjunction with the Landsat digital data. Modified clustering useage is also effective, because it

reduces display image data requirements, which in our case is limited to lineprinter output. Processing cost and analyst time requirements are not excessive since the majority of the clustering and cluster analysis is conducted with relatively small training site data sets.

TECHNOLOGY TRANSFER - THEORY & PRACTICE

PANEL CHAIRPERSON
Dr. Ida R. Hoos

(Research Sociologist - Space Sciences Laboratory
University of California
Berkeley, California

It is a great temptation to ponder technology transfer in the abstract and to deliberate about theory, for the subject is as old as the history of mankind, starts with the caveman and does not end with the astronaut. But discussions inevitably draw us into semantic wrangles over the definition of technology and what rightfully constitutes transfer.

Reviewing the conference program as a whole, one is immediately aware of its strong practical orientation. We are here to learn from one another. Our panel this afternoon reflects that orientation. We have brought together 4 experts with a wealth of experience to share. So as to derive full benefit, our focus should, I think, be on the practice side of our title, "Technology Transfer - Theory & Practice."

That being the case, I shall exercise the prerogative and make some rather arbitrary statements that will serve as axioms on which we can proceed. We will take as our definition of Technology Transfer, the one used in a Congressional Committee Report —

The transformation of R&D into processes,
products and services that can be applied
to public and private needs.

We will take as a basic premise, an assertion (paraphrased) that appeared in an Office of Technology Assessment publication —

The government is not concerned with technology transfer for its own sake. It's interest in managing or promoting technology transfer is because of the social, economic and political benefits that may result.

Technology transfer can thus be seen as what this conference is all about. I think it is especially significant to note that in a comprehensive survey on technology transfer prepared for a Congressional committee, the Remote Sensing Applications Program figured prominently.

Our task this afternoon is neither to tout successes nor to dwell on failures, for we shall learn, as the week's program unfolds, that future success may be better ensured by drawing intelligently upon the full gamut of past and present experience.

SIX MAJOR STEPS FOR A REMOTE SENSING TRANSFER MODEL
Donna B. Hankins (Technology Transfer Project
Humboldt State University
Arcata, California)

Advanced technology is providing unprecedented volumes of information, gathering, editing, storing and retrieving which has become a challenge to be met only by more advanced technology. A basic question arises. Is it worth it? To ascertain this, we must first learn how to test and use new data sources. These may be considered intrinsic to the technology transfer process, which is in itself, complicated and cumbersome. There are 6 steps essential to remote sensing technology transfer.

- 1 Examination — To allow a potential user group the opportunity to become acquainted with the technology.
- 2 Communication — The establishment of liaison and the exchange of ideas between those who transfer the technology and the potential users.
- 3 Demonstration — To enable the user group to try out the technology.
- 4 Illumination — Limitations, problems, benefits and advantages become perceptible to users.
- 5 Dissemination — Experience is shared and feedback occurs.
- 6 Operation — Adaptation occurs and the technology forms part of the organizational routine.

THE REALITIES OF TECHNOLOGY TRANSFER

Gene R. Little (Deputy Supervisor/Services
Department of Natural Resources
Olympia, Washington)

NASA's Technology Transfer Program provides a link between technology and the user. In its aim to accelerate the process, the program attempts to bring to the marketplace sooner, those things that would eventually reach it in the normal course of events. Although the program has much to be proud of and enormous potential, it could usefully reassess its position, improve its integrity and above all, select users who can implement successful and meaningful demonstration projects.

How does the remote sensing program look from the viewpoint of critical users?

- 1 The technology transfer program tends to oversell the product.
- 2 Which demonstrations have proven the technology to be operational?
- 3 The technology has shown itself to be useful only at the broadest level of classification, one not needed by most users.
- 4 Oversell at the top political levels results in topdown imposition of adoption, a condition that contributes to resistance and certain failure.
- 5 To be operational, the system must deliver the goods cost effectively, within the required time frame.
- 6 The user survey is full of exaggerations.
- 7 Due to rapid changes in the technology, there is little assurance of continuity.
- 8 Users involved in demonstration projects find it difficult to get help from NASA technical specialists.
- 9 NASA needs to determine whom to deal with and how.
- 10 NASA must expect to fund test projects fully because operating agencies likely to apply the new technology successfully, have programs in operation now and lack funds to run parallel test systems.

- 11 Better coordination and concerted effort directed to a few sophisticated users would be preferable to the present policy of diffusion.
- 12 The new technology is merely a system of classification and sampling and should be treated as such.

The features essential to any classification system selected by resource managers to replace existing systems, are clear cut and known. Although Landsat publicity implies that it can provide these features, we have not yet seen them achieved through Landsat.

Here is the challenge. If your technology could classify the urban, agricultural or forestry related resources in the State of Washington by broad biological and condition classes for each of several ownership classes, we would use it immediately. If the accuracy, timeliness and cost effectiveness were anywhere near the installed accuracy and precision of our existing system, we would use it immediately. If we could be reasonably certain that the technology would be in place or at least be able to be replicated and compared 5 or 10 years from now, we would use it immediately.

TECHNOLOGY TRANSFER AS A PERSONALIZED PROCESS
Barry Schrumpf (Oregon State University
Corvallis, Oregon)

Of primary importance in getting new technology accepted is initial success. If an agency has not this assurance at the outset, it cannot invest in further exploration of utility. In view of the considerable resistance to innovation, especially when current practice is regarded as satisfactory, advantages must be immediately and impressively evident. Rationalizations, such as "better information" occur only afterward. Only in the rare instance when an agency is obliged to repond to a new task for which there are no existing mechanisms does there appear the unique opportunity for new technology. This cannot be construed, however, as the usual vehicle for technology transfer.

What will motivate agency personnel to accept a new technology?

- 1 Development of their own belief that the new technology will work for them.
- 2 The conviction that cost-saving and time-saving can be achieved.

When has a technology been transferred:

- 1 When an agency will commit their own (unsubsidized) support to the project.
- 2 When an agency establishes an inhouse understanding of the technology and commits staff time to project planning.

How do you achieve a viable technology transfer process?

- 1 Find the key agency person whose attributes include an inquisitive mind and an understanding of his peers.
- 2 Listen to that person so as to learn and understand his agency's information needs.
- 3 Use the appropriate combination of technologies to meet real needs, since no one approach may be suitable.

- 4 Do all you can to make the first project a successful one, since at best, this is only a foot-in-the door, a springboard to future opportunity.
- 5 Follow through with the agency to broaden and diversify applications.

SESSION III

18 OCTOBER 79 THURSDAY (AM)

WESTERN REGIONAL REMOTE SENSING CONFERENCE
CONVENED AT
THE NAVAL POST GRADUATE SCHOOL
KING HALL
MONTEREY, CALIFORNIA

SPONSORED BY NASA AMES RESEARCH CENTER
MOFFETT FIELD, CALIFORNIA

A THE ROLE OF THE NATIONAL GOVERNOR'S ASSOCIATION IN
REMOTE SENSING

Peggy Harwood (NGA Earth Resources Data Council
Washington, DC)

Speaking for the National Governor's Association's (NGA) Earth Resources Data Council, Peggy Harwood identified kinds of information the NGA seeks on a national level. NGA publishes a newsletter summarizing the status of remote sensing activities, covering topics such as orbit determination, data collection, nationwide high altitude aerial photography and current legislation.

NGA wants to contribute, at a national level, information beneficial to users in a variety of applications, Harwood stated. Whenever possible, NGA will support primary objectives meaningful to all interests and users, she added.

B REMOTE SENSING APPLICATIONS IN FORESTRY

PANEL CHAIRPERSON (California Department of Forestry
Dale Wierman Sacramento, California)

SESSION SUMMARY

SPEAKERS

Nancy Tosta-Miller	(California Department of Forestry)
Edwin A.P. Petteys	(Hawaii Division of Forestry)
R. Ronan Thornhill	(Nevada Division of Forestry)
Robert B. Scott	(Washington Department of Natural Resources)

Forests of the Western United States cover hundreds of millions of acres. Those forests which have not been converted to cities, vineyards, orchards, pastures, parks, etc., are no longer viewed by our public as an endless timber or land reserve. There has been a realization that our forests provide much more than timber and land. Our society is to a great extent, dependent upon all of our forests as a renewable resource.

Forest land management contrasts sharply with that of agricultural lands in many ways. These distinctions have made forest land managing agencies and private entities long term users of remote sensing technology. Operational commitment of Landsat technology in forest management or regulatory programs, has not been made. However, many projects indicate potential for its use as a cost effective element of a data base for the future.

The Washington State Department of Natural Resources has extensive forest land management responsibilities. Data needs to support management decisions on productive timberland, resulted in a comprehensive remote sensing program to be developed and maintained. This includes extensive procurement and use of aerial photography and 6 projects investigating the integration of Landsat techniques into operational programs.

- 1 Western Washington Forest Productivity Study — Involved the development and evaluation of a new regional forest survey method which integrated digital image processing, multistage sampling, aerial photographic interpretation and traditional field sampling methods.
- 2 Cooperative DNR & US Forest Service Landsat Regional Inventory — Currently investigating the integration of Landsat with present regional survey methods in contrast to the proceeding study which involved the development of a new method.
- 3 Landsat Operational Inventory (Western Washington) — Evaluated the capability of Landsat to provide detailed forest management data.

- 4 Clearcut Monitoring Study — A cooperative project with the Department of Revenue to use multidate digitally-processed Landsat data to more efficiently enforce the State's Timber Yield Tax Law.
- 5 Landsat Operational Inventory (Eastern Washington) — Evaluates the capability of Landsat to provide resource data for Eastern Washington forest types and use of topographic data for improving forest classification.
- 6 State of Washington Information Service — Currently being developed by the DNR. This projects goal is to combine statewide mapping, geoprocessing and remote sensing activities into an information service that will satisfy diverse resource planning and management needs of county, state and federal agencies. Emphasis is placed on discussing the role of Landsat in this information service concept.

The Hawaii Division of Forestry has extensive forest land management responsibilities on several islands. Approximately half the state, two million acres, is forested and exhibits considerable environmental and ecological diversity. These forests are managed within the multiple use concept by a relatively small staff. The uses of remote sensing, mainly conventional aerial photography, are varied due to lack of access and the rugged nature of the terrain.

There are several problems that do not lend themselves to solutions by conventional aerial photography. Landsat is being considered as a tool in attaining a solution. Problems involve vegetation and land use mapping, resource data bank establishment and management, forest pest surveys and ecosystem mapping.

Preliminary results of investigations into Landsat have been promising. The Hawaii Division of Forestry will be recommending the adoption of a processing system to its state legislature in the near future.

The Nevada Division of Forestry has minimal forest management responsibility on state lands. With 80% of the land area under federal ownership and the arid nature of major land areas, there has been little opportunity in the past, though assistance to private landowners is provided. A pilot study in the Douglas County and Carson City areas will evaluate the capability of Landsat to inventory and map various coniferous types by 6 classes of ownership and incorporate correlations between tree crown closure and basal area of forest types.

The California Department of Forestry (CDF) expends little of the annual budget managing forest lands. These lands (+ 42 million acres) are nearly equally divided between private and federal ownership. Until enactment of the Forest Resources Assessment & Policy Act (FRAPA) in 1977, the CDF was principally involved in regulatory aspects of timber harvesting on private forest land and wildlife fire protection.

Within CDF, post FRAPA, a periodic analysis and assessment of the supply and demand for forest resources and important policy considerations affecting management of all forest resources in California, is to be completed. Complete and objective analysis in the future will depend upon a much better data base being developed.

An attempt was made this past year to utilize Landsat data to establish a Forest Land Data Base. August 1976 Landsat scenes were mosaicked together statewide. An unsupervised classification was completed and 16 land cover classes were identified. This included 6 forest classes of pure and mixed hardwood and conifer types. Within this next year, efforts will be made to refine this classification, using supervised techniques on certain selected counties. Ancillary information such as soils, terrain or ownership delineations will be considered in efforts to develop a Forest Land Management Information Base.

C USER NEEDS ASSESSMENTS

PANEL CHAIRPERSON (Remote Sensing Applications Laboratory
Dr. Frank Westerlund University of Washington
Seattle, Washington)

Introductory Remarks

This conference has heard much critical discussion of technology transfer issues and of Landsat technology itself. The familiar question has been raised, is Landsat a solution in search of a problem? Clearly, in some cases the answer is yes, because we do not have an ideal world in which the needs of all potential users can be determined prior to beginning development and use of a tool, like Landsat, that promises to have wide range application and benefit.

Identification of needs must be the driving force behind each specific instance of technology application. Identification should, along with evidence of cost effectiveness, provide justification for every effort of technology transfer at whatever level it occurs - from an individual user to an entire state. For this to happen, needs must be made explicit. Otherwise, it is just too easy to gloss over them. This brings us to the central issues addressed by this panel.

- How do you identify real needs in the first place?
- How do you define and describe them?
- How do you document them?
- How do you do this in a systematic and unbiased way?

The needs we are talking about, of course, are needs for information about land resources, to serve operational decision making at different levels of government. Substantive range of land resource information is great. Many physical, spatial and temporal parameters are required to describe it. To arrive at these definitions requires an examination of the needs basis, the user organization and its mandates and different kinds of decision making that occur, from upper level managers to people in the field.

Equally important are questions of who does a needs assessment, what is its scope, when does it occur and what are the purposes and motivations. Every data user knows, basically, what he or she needs and makes this assessment frequently. But if we are considering data collection or data management technology to meet the collective needs of many users, such as Landsat or GIS, we have to look at a user community and needs

assessment becomes a specialized task usually performed by someone on the outside at one point. The question of who surveys whom, can involve political sensitivities. For this reason, users direct involvement in the conduct of needs assessments is highly desirable. No matter how collective the results, a needs assessment must address perceived needs of individual data users as well as stated or presumed requirements of legislation and other mandates.

There are methodological issues of how to conduct an assessment, how to organize participants, what survey instruments to use, how to present the findings and what subsequent analyses to perform. Relatively little established methodology seems to exist. Finally, there is the question of what to do with the results. What mechanisms exist for assimilating and using this information or does it wind up on a shelf? These issues assume major proportions when you think about a state attempting to comprehensively assess its information needs. Several states have begun such a process.

User Needs Assessments in Alaska/Hawaii/California/North Dakota

Panel members have all been involved in statewide needs assessments and they represent a variety of experience in this area.

Dr. Lloyd Eggan of the Alaska Department of Natural Resources, heads a task group within the interagency Alaska Land Managers Cooperative Task Force that is conducting a data needs survey among a dozen state and federal resource agencies. This survey is a good example of a well coordinated, user participatory effort at comprehensively assessing needs for land resource information. Moreover, it provides a set of requirements for development of commonly accessible systems of data collection and management.

Mr. Michael Munekiyo of the Hawaii Department of Planning & Economic Development directed a mode limited survey conducted at the outset of the state's Landsat demonstration program by Hawaii's Ad Hoc Committee on Remote Sensing. This survey was developed specifically to identify potential applications of remote sensing data as a basis for designing the demonstration program. Mr. Munekiyo emphasized the advantages of conducting a needs survey through a small, inhouse team of agency representatives within the traditionally close working environment of Hawaii state agencies. Results were obtained quickly with a minimum of disagreements. The data could be applied directly to program plans because of the group's cohesiveness and inhouse status within an already cohesive group of user agencies.

Mr. Steven Kraus of the California Governor's Office of Planning & Research has been involved, along with the California Environmental Data Center, in a study not only of data needs, but of their counterpart - existing data collection programs and reference information concerning data. He emphasized the subjects sensitive nature and the importance of conducting face-to-face interviews with agency managers to establish confidence and avoid misconceptions about the purposes of such a survey. In particular, the issue of data sharing must be addressed with care due to its possible or perceived relationship to agency funding for data collection and management. Mr. Kraus stressed the benefits users may derive from sharing data and from development of a centralized data reference source. He notes that a California Environmental Data Center goal is to establish such an information clearinghouse for data sources.

Dr. Roland D. Mower, Director of the University of North Dakota Institute for Remote Sensing described the intergovernmental team approach taken to develop capabilities required for North Dakota's Regional Environmental Assessment Program (REAP) system.

All 4 of these state needs assessment efforts involved considerations of objectives, support, organization, participation, implementation and analysis and use of results, that deserve extended discussion. It was decided to include detailed description of two activities in these proceedings. Inquiries about the user needs assessments for Alaska, Hawaii, California and North Dakota should be addressed to their respective panel members.

THE ALASKA DATA NEEDS SURVEY

Dr. Lloyd Eggan (Department of Natural Resources
 Anchorage, Alaska)

The Alaska Interagency Data Needs Survey is, in part, an outgrowth of a similar effort within the Alaska Department of Natural Resources (DNR) to assess its information requirements. In mid 1978, the DNR Commissioner initiated a department-wide program to develop a system of automated data handling mechanisms to support the department's massive land and resources management activities. A Design Group was established. The groups first identified task was to conduct a user needs survey covering DNR's entire land and resource management activities.

At the same time, the Alaska Remote Sensing Task Force, an interagency group established under the then Federal-State Land Use Planning Commission for Alaska, decided to survey Alaskan resource agencies. The purpose was to identify needs that could be addressed through remote sensing application technology, preparatory to initiating a demonstration program with NASA/WRAP (and ASVT) support. DNR and the Remote Sensing Task Force met and with assistance from NASA, collaborated in the development of a survey form designed to be self-administered within agencies. DNR then administered the survey inhouse through its Design Group, whose members were each responsible for obtaining required information from their respective divisions or sections.

When this approach began to produce results for DNR, the Remote Sensing Task Force sought a comparable coordination mechanism for its interagency survey. The Federal-State Land Use Planning Commission was nearing its legislated termination and could not serve this function. Another interagency group was formed, the Committee on Natural Resource Information Management (CONRIM). CONRIM was established under the Alaska Land Managers Cooperative Task Force, created 2 years ago through a memorandum of agreement signed by the Governor of Alaska, the Secretaries of Interior and Agriculture and the President of the Alaska Federation of Natives. This task force provides a permanent coordination mechanism for agencies and organizations that own or manage 95% of Alaska's land. These include Alaska DNR and Fish & Game, US Fish & Wildlife Service, BLM, Forest Service, Park Service, SCS and the Alaska Federation of Natives, representing the Native regional and village corporations.

CONRIM is one of many advisory committees established under the Land Managers Task Force to address areas of common concern. Others include Flood Plain Management, Wildfire Control, Reindeer Herding, Bristol Bay Region Cooperative Management, Vegetation Classification and Recreation

Coordination (CONRIM) is charged with addressing common issues relating to resource data collection, exchange and management and related technology applications, particularly geographic information systems.

The Remote Sensing Task Force, with DNR support, approached CONRIM and requested that it sponsor the interagency Data Needs Survey. CONRIM, seeing value in such a survey as a driver for many of its own anticipated activities, agreed to this proposal and a Data Needs Survey Task Group composed of a few agency representatives was established. The groups purpose was to coordinate the survey, not conduct it. Each agency thought to have some interest in resource information was contacted and asked to designate a lead individual. These people were responsible for administering the survey within their organizations.

An orientation workshop was held by the Task Group to acquaint agency lead persons with survey objectives. The rationale and format of the survey form and procedural guidelines intended to achieve consistency of results. Alternative ways of administering the survey within an agency were suggested. These included —

- 1 Inhouse agency orientation by the lead person (with assistance by the Task Group if requested) followed by survey form distribution to all sections and program managers.
- 2 For geographically distributed agency offices, mailing of the form with written instructions and telephoned explanations and follow up by the lead person.
- 3 Lead individual confers with each program manager and jointly complete the form.
- 4 Lead individual completes all copies of the form after obtaining necessary information from each respondent by direct interview, telephone or correspondence.

Each agency lead was requested to submit a 1 page implementation plan explaining how the survey would be administered. A form for this was provided, requesting information on anticipated respondents, their number, organizational location and program responsibilities, method of contact, provisions for inhouse review and follow up if needed, any foreseen problems and completion date.

The survey form is a 4 page document. One copy of the form is intended to be completed for each program, project or activity in an agency making some use of physical land resource data or other georeferenced data.

The three terms, "program," "project" and "activity" were provided because it was found that different agencies use them in varying ways to describe their operations. In many cases "program" is used to define a set of closely related tasks addressing a legislative mandate, with management responsibility assigned to one individual. Other agencies, for example, Fish & Game, perform many ongoing activities under a general mandate, and are funded to do other investigations described as "projects." The form permits appropriate term selection with indication of its context, i.e., an activity, under a program or other mandate, performed by a particular division or section of the agency.

The form's first page identifies the respondent and activity (project, program) and asks the following questions about the activity —

- 1 Briefly describe the activity
- 2 Under what legislative authority is the activity mandated (cite specifically)?
- 3 What are the purposes of this activity? What are the products and actions resulting from the activity?
- 4 How important is the activity in terms of your total operation? What percentage of your resources (personnel, money, time) are committed to this activity?
- 5 Is this activity performed continuously or on a problem by problem basis? Is this a temporary or long term activity?

The second page asks: What questions must be answered by decision-makers in the course of conducting this activity, e.g., size of area? Number of people? Land cover characteristics? Type of vegetation? The resulting list of questions are to be incorporated as row items in the matrix which appears on Page 4.

Page 3 of the form is a detailed description of each column items in the matrix. First of these is an identification of data elements required to answer each question transferred to the matrix from Page 2. Data elements should be defined in specific terms including parameter units of measure, if applicable (e.g., land area in acres), or a specific land classification system and the level of detail required. Each data element identified for each question also generates a row in the matrix.

Succeeding columns pertain to required data formats and spatial/temporal parameters such as scale, geographic coverage, resolution (minimum area or mapping units), timing (of data collection), response time (required turnaround on data requests), currency and frequency of use. Each parameter is carefully defined and distinguished from the others.

The last 2 columns in the matrix request identification of data sources if any, currently used for each data element and an assessment of the adequacy of these sources in terms of the matrix parameters or other factors. Respondents were instructed to use the matrix to define generic data requirements, not characteristics of presently used data, unless these were seen to satisfactorily coincide.

The following agencies had participated in the survey and returned forms by mid 1979.

State

Department of Natural Resources
Department of Fish & Game
Department of Environmental Conservation
Department of Transportation & Public Facilities
Department of Community & Regional Affairs

Federal

Fish & Wildlife Service
National Park Service
Bureau of Land Management
Forest Service
Soil Conservation Service
Agricultural Stabilization & Conservation Service
Department of Housing & Urban Development

Interagency

Flood Plan Management Committee, Alaska Land Managers
Cooperative Task Force

An average of 5-10 forms were received from each agency, with a far larger number from a few agencies such as DNR. CONRIM and the Task Group are now considering means of compiling information from the survey to indicate common and priority data needs among the agency community, particularly as related to key interagency programs.

This compilation and original forms will then be examined from several perspectives. CONRIM will use this information to determine priorities for concentration of effort related to information exchange, data sharing and networking and GIS coordination. As a complement to the Data Needs Survey, another CONRIM task group has begun an inventory of existing data bases and systems in Alaska, with a view toward merging the two efforts.

The Remote Sensing Task Force (since reconstituted as a subcommittee of CONRIM) is using the survey to identify potential applications of remote sensing as an input to the state's Landsat Demonstration Program (a NASA ASVT starting FY 1980). This analysis is being conducted by Dr. Paula Krebs of the University of Alaska Geophysical Institute with NASA/WRAP support.

Several of the participating agencies have already made internal use of the survey results. DNR has used the survey to establish specifications for acquisition of a geoprocessing system and for design of a land administration data base. The Department of Fish & Game has also used the survey to begin a conceptual design of an information system.

As a concluding observation, a major value of the survey to date has been in the process, not the product. It has given agencies an opportunity and a tool for examining and better defining their roles and operational activities, and types of informational support these activities require. Doing this in concert with other agencies has promoted awareness of a user community that can work together to address common needs.

Finally, the survey has assisted in preparing users for technology transfer by creating both awareness of needs and interest in potential solutions.

NORTH DAKOTA'S EXPERIENCE IN USER NEEDS SURVEYS FOR REAP
Dr. Roland D. Mower (Institute of Remote Sensing
University of North Dakota
Grand Forks, North Dakota)

The North Dakota Regional Environmental Assessment Program (REAP) was established by the 1975 Legislative Assembly of the State of North Dakota. REAP was charged with research on North Dakota's resources and development of an information and assessment system. The legislative mandate appeared to emphasize need for timely collection and analysis of information required by members of state government for administrative and policy decisions. In response, REAP evolved the concept for an automated, geo-based, information system. A two-phase approach was used to achieve this goal. Phase I involved requirements analysis and conceptual design for REAP. Phase II of the design effort included a systems analysis and plan. The second phase was divided into two tasks, with Task 1 being an elaboration of the Systems Analysis Details and Task 2 being the System Description and Plan. This paper is an elaboration of Task 1.

The major objective of Task 1 was to describe in detail, capabilities desired for the REAP system. The approach taken was to form a series of 10 REAP User Specification Teams (RUSTEAMS), comprised largely of representatives of units of federal, state and local government which were expected to be primary REAP system users. The RUSTEAMS, organized by discipline (air quality-meteorology, animals, geology, historic-archaeologic-paleontologic sites, land use, social impact, socioeconomic impact, soils, vegetation, water) were asked to complete a series of 20 forms prepared by IBM/FSD. The RUSTEAMS focused on describing output report titles, and from that point elaborated input data requirements, output report details, processing and analysis requirements and modeling requirements. Analysis, summarization and prioritization of RUSTEAM results by the REAP staff resulted in a Systems Analysis Details Report which served as a guideline for REAP information system development. The key factor recognized by REAP during development of their facilities was that data needs and analysis must be user driven.

Use of appointed RUSTEAMS was the key to REAP's initial success. These teams were comprised of primary and secondary users, as well as some data resource groups. Because of the complexity of the systems analysis task, and particularly the need to understand use of potential REAP products and data available to generate products, the REAP staff judged that data users and data providers should be represented. Of the total 53 members, 31 represented state agencies, 6 represented federal agencies, 12 represented universities, 1 represented private industry and 3 represented local governments. Experts selected for the RUSTEAMS were identified by the REAP staff primarily on the basis of results from Technical Task Force meetings convened in the fall of 1975.

Through use of 20 individual forms, prepared by IBM, each RUSTEAM was asked to provide a large number of specific information items. They were first asked to identify and confirm specific user needs within their discipline in terms of system output. Each output report title identified by RUSTEAM members was therefore related to the primary and secondary users expected to need that report. The second part of the RUSTEAM task was to provide specific information on all existing and still needed data for satisfying requirements of the identified output report title. Each RUSTEAM'S final task was to rank each output report title. They were ranked on the basis of need immediacy by REAP, expected benefits to REAP, input data availability, difficulty in acquiring missing data, availability of technology to produce the report and complexity of implementing that technology.

Three prime factors controlled the effectiveness of RUSTEAM efforts. The first of these was each team's size. As a result of the experience gained from the Technical Task Force meetings in the fall of 1975, it was concluded that optimum size for a RUSTEAM would be about 5 members. By restricting the size of the RUSTEAMS, it was evident not all subdivisions of each RUSTEAM subject area would be represented. This deficiency was accepted from the initial organization of the teams. It was anticipated that appointed members would have enough personal associations within their organizations or agencies to cover these deficiencies.

The second factor was that the RUSTEAMS characteristically focused on existing data and familiar uses of such data. Many factors contributed to this deficiency, including RUSTEAM composition and interpretation placed on RUSTEAM forms.

A third limitation was more serious. Amount of time available for actual RUSTEAM meetings and the magnitude of the required effort were incompatible. By cutting down required meeting time and assigning additional work for completion between sessions, it was determined that a fair degree of form completeness could be achieved.

SESSION IV

18 OCTOBER 79 THURSDAY (PM)

WESTERN REGIONAL REMOTE SENSING CONFERENCE
CONVENED AT
THE NAVAL POST GRADUATE SCHOOL
KING HALL
MONTEREY, CALIFORNIA

SPONSORED BY NASA AMES RESEARCH CENTER
MOFFETT FIELD, CALIFORNIA

A

FEDERAL PROGRAMS IN REMOTE SENSING

PANEL CHAIRPERSON
Donald T. Lauer

(EROS Data Center - US Geological Survey
Sioux Falls, South Dakota)

Introductory Remarks

In the 90 minutes allotted to the session entitled "Federal Programs in Remote Sensing", the chairperson decided to provide a program with 3 speakers representing each of the 3 major Federal user agencies.

Speakers were asked to present not detailed remote sensing application examples, but rather overview papers on department-wide activities. Specifically, each speaker was asked that he use a three-part format to include —

- 1 Overview of current programs and activities
- 2 Recent significant developments
- 3 Anticipated future developments

Messrs. Watkins, McArdle and Weisnet are knowledgeable and experienced scientists. In my opinion, these gentlemen represent their respective departments well. The text and charts which follow only briefly summarize their 30 minute presentations.

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THE ROLE OF REMOTE SENSING IN THE DEPARTMENT OF INTERIOR
Allen H. Watkins (EROS Data Center - US Geological Survey
Sioux Falls, South Dakota)

Since its creation in 1849, USDI has faced the challenging mission of being custodian of the Nation's natural resources. USDI is directly responsible for management of 30 % of the United State's land area, including administration of more than 600 million acres of Federal land and 300 million acres of subsurface lands where mineral rights have been retained by the Federal Government. Interior's responsibilities include —

- 1 Conservation/development of mineral and water resources
- 2 Promotion of mine safety/efficiency
- 3 Conservation/development and utilization of fish and wildlife resources
- 4 Coordination of Federal/State Recreation Programs
- 5 Preservation/administration of the Nation's scenic and historic areas
- 6 Reclamation of arid lands in the west through irrigation
- 7 Management of hydroelectric power systems

USDI has major resource management responsibilities in the 200 mile zone of the Continental Shelf, vast and mostly uncharted areas of Alaska, Trust Territories of the United States and Antarctica, as well as cooperative efforts in foreign countries on behalf of the Agency for International Development.

USDI requires remote sensing technology to fulfill many of its major responsibilities for inventorying resources, managing public lands and protecting the environment. USDI has demonstrated the applicability of remote sensing technology which includes —

- Actual and potential land use/cover mapping
- Impact assessment of man's actions on vegetation, soil and cultural resources

- Survey of vegetation productivity, condition and trend
- Predicting occurrences of geothermal energy resources, petroleum deposits, energy mineral deposits and metallic/nonmetallic mineral deposits
- Inventories of surface/subsurface water resources
- Assessment of lake, river, reservoir, estuary and Outer Continental Shelf conditions
- Communications of data, voice and video for monitoring both normal events and disaster situations

Specific high priority applications of remote sensing technology within USDI bureau's follow —

Bureau of Land Management

Natural Resource Inventory
 Natural Resource Monitoring
 Telecommunications Improvement
 Geographic Positioning

Bureau of Reclamation

Water Management
 Irrigated Land Inventory
 Agricultural Crop Inventory
 Hydrometeorological Data Relay
 Mesocale Cloud Analysis

Fish & Wildlife Service

Migratory Bird Management
 Habitat Inventory & Analysis

Geological Survey

Land Cover Mapping
 Water Management
 Cartographic Mapping
 Geologic & Mineral Assessment
 Conservation & Regulation

National Park Service

Vegetation/Land Cover Inventory
Resource Condition Monitoring
Environmental Quality Monitoring
Emergency Communications
Environmental Education

Although these major activities relate primarily to Federal areas administered by USDI, remote sensing technology is equally applicable to areas under the jurisdiction of state and local agencies. This technology also applies to areas being explored and developed by mineral and petroleum industries, both domestically and internationally.

USDI has played a major role in developing the applications and transferring aircraft and satellite remote sensing technologies to these organizations.

INTERIOR PROGRAMS IN REMOTE SENSING

- BROAD RESPONSIBILITIES FOR MANAGEMENT OF FEDERAL LANDS AND MINERAL RIGHTS
 - 30 PERCENT OF U.S. LAND AREA
 - 300 MILLION ACRES OF SUBSURFACE LAND
 - CONTINENTAL SHELF
- APPLICATIONS OF REMOTE SENSING
 - ACTUAL AND POTENTIAL LAND USE/COVER MAPPING
 - IMPACT ASSESSMENT OF MAN'S ACTIONS ON VEGETATION, SOIL, AND CULTURAL RESOURCES
 - PREDICTING OCCURRENCES OF GEOTHERMAL ENERGY RESOURCES, PETROLEUM DEPOSITS, ENERGY MINERAL DEPOSITS, AND METALLIC/NONMETALLIC MINERAL DEPOSITS
 - SURVEY ON VEGETATION PRODUCTIVITY, CONDITION, AND TREND
 - INVENTORIES OF SURFACE/SUBSURFACE WATER RESOURCES
 - ASSESSMENT OF LAKE, RIVER, RESERVOIR, ESTUARY, AND OUTER CONTINENTAL SHELF CONDITIONS
- SATELLITE REMOTE SENSING PROGRAM PARTICIPATION
 - HISTORICAL ROLE OF LEADERSHIP
 - LANDSAT DATA PROCESSING AND DISTRIBUTION
 - TECHNOLOGY TRANSFER
 - DEVELOPMENT OF APPLICATIONS TECHNIQUES

RECENT SIGNIFICANT DEVELOPMENTS

- LANDSAT 2/3 DIGITAL DATA PROCESSING SYSTEM AND DOMSAT COMMUNICATION LINK
- PLANS FOR ALASKAN REMOTE SENSING FIELD OFFICE
- OFFICE OF SURFACE MINING CONTRACT WITH DOE/OAKRIDGE LABORATORIES
- NEW MACHINE ANALYSIS CAPABILITIES WITHIN BLM AND BOR
- PLANS FOR U.S. HIGH-ALTITUDE AIRCRAFT COVERAGE
- STATUS AND RESULTS OF
 - PRIVATE SECTOR INVOLVEMENT STUDY
 - INTEGRATED REMOTE SENSING SYSTEM STUDY
 - INSTITUTIONAL ISSUES STUDY

CONCEPTUAL APPROACH FOR MANAGEMENT OF AN OPERATIONAL EARTH
RESOURCES SATELLITE REMOTE SENSING PROGRAM

● INSTITUTIONAL RELATIONSHIPS

- INTERAGENCY BOARD OF DIRECTORS
- FULL STAFF SUPPORT AND CHAIRMANSHIP BY THE LEAD AGENCY
- WORKING LEVEL COMMITTEES
- OMB AND OSTP AS "REFEREES"
- LEAD AGENCY FOR OPERATIONAL ACTIVITIES
- NASA CONTINUES SYSTEMS R&D
- USER AGENCIES CONTINUE APPLICATIONS R&D

● RESOURCES

- BUDGETARY LINE ITEM APPROXIMATELY \$100-\$200 MILLION PER YEAR

● USER REQUIREMENTS COORDINATION

- INTERAGENCY BOARD OF DIRECTORS
 - USER AGENCIES (FEDERAL, STATE, AND LOCAL)
 - PRIVATE SECTOR
 - INTERNATIONAL GROUPS

● DATA CONTINUITY

- BALANCE TECHNOLOGY IMPROVEMENT AND DATA TYPE/FORMAT COMPATIBILITY
- SENSORS AND SYSTEMS PROVEN IN R&D PHASE
- DUPLICATE CAPABILITY DURING TRANSITION PHASES
- LAUNCH-READY SPARES

- R&D VERSUS OPERATIONAL ACTIVITIES
 - COORDINATION BETWEEN OPERATIONAL SYSTEM AND NASA
 - ALL DATA AVAILABLE
 - DIFFERENT DATA ACQUISITION AND HANDLING CONCEPTS AND GROUND RULES
- USER APPLICATIONS
 - CONTINUED USER RESPONSIBILITY
 - PROGRAM REVIEW FOR BALANCE OF RESOURCES
- INTERNATIONAL ISSUES
 - GLOBAL NETWORK AND DATA COMPATIBILITY
 - FOREIGN STATIONS
 - FOREIGN SATELLITES
- PRIVATE SECTOR INVOLVEMENT
 - EVOLUTIONARY BASED ON TECHNOLOGICAL MATURITY AND USER ACCEPTANCE
 - PERIODIC ASSESSMENT AND CHANGE IN GUIDANCE BY INTERAGENCY BOARD
 - PRIVATE SECTOR REPRESENTED ON BOARD
- REPORTING
 - ANNUAL REPORTS
 - MAJOR PROGRAM ASSESSMENTS ON 5-YEAR BASIS
- REQUIRED LEGISLATION
 - ADMINISTRATIVE ASSIGNMENT
 - CONGRESSIONAL LEGISLATION

- CONCEPTUAL CONFIGURATION

- SPACE SEGMENT

- MONITORING SATELLITES
 - SPECIALTY SATELLITES
 - CHARACTERISTICS

- GROUND SEGMENT

- TDRSS AND WHITE SANDS
 - CENTRAL PROCESSING AND DISTRIBUTION FACILITY
 - MAJOR USERS RECEIVE DIRECT WHEN REQUIRED
 - RAW OR PROCESSED DATA

THE ROLE OF REMOTE SENSING IN THE DEPARTMENT OF AGRICULTURE
Richard C. McArdle (World Food & Agriculture Outlook &
Situation Board
Washington, DC)

The Department of Agriculture is one of the oldest and largest civilian users of remote sensing in the Federal Government. Until the early 1970's, the principal sensor was the aerial camera to provide aerial photography for use in support of major departmental missions. Development of satellite platforms and other sensors, such as the Multispectral Scanner, led to large-scale developmental and testing programs to link most effective applications to current needs.

Current Activities

Today, current and historic aerial photography is still used extensively for day-to-day program activities. For such varied uses as soil surveys, cropland and forest inventories, and agricultural renewable resources management, aerial photography is a commonplace and indispensable tool in the United States. Data acquisition from satellites permitted the Department to extend its capability to monitor crop conditions in major agricultural regions of the world.

Recent Significant Developments

The Department has undertaken a major research program which seeks ways to incorporate space remote sensing into its ongoing activities. AgRISTARS (Agricultural & Resource Inventory Surveys through Aerospace Remote Sensing) will include all department research related to remote sensing. This program is multi-agency, with the Departments of Agriculture, Commerce & Interior, NASA and AID as participants. AgRISTARS overall goal is to determine usefulness, costs and the extent to which aerospace remote sensing can be integrated into existing and future USDA information systems. Specific objectives include development and evaluation of applications related to early warning of changes in crop conditions, crop production forecasts and land and renewable resource inventories.

Anticipated Future Developments

The AgRISTARS research program, which begins in FY 1980, will continue through FY 1985. It is anticipated that the department's space research efforts will take place within this program. In addition, it is hoped that substantial progress will be made toward integration of space

remote sensing data in crop monitoring and assessment (including yield and acreage determination), renewable resources management, conservation practices assessment and pollution detection. These efforts should be assisted by development of new sensors, such as the thematic mapper.

Aerial photography will not be neglected. The department is exploring possible acquisition of high-altitude, high-resolution photography as part of a multi-agency program.

STATUS OF REMOTE SENSING IN USDA

CURRENT ACTIVITIES

"MAJOR" REMOTE SENSING AGENCIES

FOREST SERVICE

SOIL CONSERVATION SERVICE

ECONOMICS, STATISTICS AND COOPERATIVES SERVICE

FOREIGN AGRICULTURAL SERVICE

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

SCIENCE AND EVALUATION ADMINISTRATION

COORDINATION, SUPPORT

WORLD FOOD AND AGRICULTURE OUTLOOK AND SITUATION BOARD

OFFICE OF OPERATIONS AND FINANCE

FEDERAL CROP INSURANCE CORPORATION

OFFICE OF BUDGET PLANNING AND EVALUATION

ANIMAL AND PLANT HEALTH INSPECTION SERVICE

HIGHLIGHTS OF AGENCY PROGRAMS

FOREST SERVICE

- NATIONWIDE FORESTRY APPLICATION PROGRAM
 - IDENTIFY NEW METHODS
 - RENEWABLE RESOURCES INVENTORY PROCEDURES
 - MANAGEMENT OF FORESTS AND RANGELANDS

SOIL CONSERVATION SERVICE

- LAND USE MAPPING
- SOIL SURVEYS
- SNOW COVER

ECONOMICS, STATISTICS AND COOPERATIVES SERVICE

- CROP ACREAGE ESTIMATION
- SAMPLING FRAMES
- LAND USE INVENTORY

FOREIGN AGRICULTURAL SERVICE

- CROP CONDITION ASSESSMENT DIVISION

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

- AERIAL PHOTOGRAPHY OF RURAL AREAS

SCIENCE AND EDUCATION ADMINISTRATION

- EARLY WARNING
- CROP YIELDS
- SOIL MOISTURE
- POLLUTION DETECTION

RECENT SIGNIFICANT DEVELOPMENTS

AgRISTARS

- AGRICULTURE AND RESOURCE INVENTORIES THROUGH AEROSPACE REMOTE SENSING
- RESEARCH
- OVERALL GOAL IS TO DETERMINE USEFULNESS, COSTS, AND EXTENT TO WHICH AEROSPACE REMOTE SENSING TECHNOLOGY CAN BE INTEGRATED INTO EXISTING AND FUTURE USDA INFORMATION SYSTEMS
- USDA, USDC, USDI, NASA, AID
- FY 1980 - FY 1985

ANTICIPATED FUTURE DEVELOPMENTS

AgRISTARS -- THROUGH FY 1985

APPLICATIONS IN OPERATIONAL TEST ENVIRONMENT

NEW SENSORS

HIGH ALTITUDE, HIGH RESOLUTION PHOTOGRAPHY

"ECONOMIC FEASIBILITY"

STATUS OF REMOTE SENSING IN USDA

AgRISTARS APPROACH

THE APPROACH WILL PROVIDE A BALANCED PROGRAM OF REMOTE SENSING RESEARCH AND DEVELOPMENT, COMBINED WITH USER-CONDUCTED LARGE SCALE APPLICATION TESTS AND THE TRANSFER OF PROCEDURES FOR USING REMOTE SENSING DATA TO SUPPORT DEPARTMENT ANALYSES

AgRISTARS IS ORGANIZED INTO EIGHT MAJOR PROJECT AREAS WITH LEAD AGENCY RESPONSIBILITY ASSIGNED TO VARIOUS AGENCIES

- (1) EARLY WARNING/CROP CONDITION ASSESSMENT (USDA/FAS)
- (2) FOREIGN COMMODITY PRODUCTION FORECASTING (NASA)
- (3) YIELD MODEL DEVELOPMENT (USDC/NOAA)
- (4) SUPPORTING RESEARCH (NASA)
- (5) SOIL MOISTURE (USDA/SCS)
- (6) DOMESTIC CROPS AND LAND COVER (USDA/ESCS)
- (7) RENEWABLE RESOURCES (FOREST AND RANGE) (USDA/FS)
- (8) CONSERVATION AND POLLUTION (USDA/CEA)

AGRISTARS PROGRAM OBJECTIVES

- (1) DEVELOP, TEST AND EVALUATE PROCEDURES FOR ADAPTING REMOTE SENSING TECHNOLOGY IN ORDER TO IMPROVE THE DEPARTMENT'S CAPABILITY TO PROVIDE EARLY WARNING AND TIMELY ASSESSMENT OF CHANGES IN CROP CONDITIONS.
- (2) DEVELOP AND TEST PROCEDURES FOR USING SATELLITE REMOTE SENSING TECHNOLOGY TO PROVIDE (A) MORE OBJECTIVE AND RELIABLE CROP PRODUCTION FORECASTS SEVERAL TIMES DURING THE GROWING SEASON, AND (B) IMPROVED PRE-HARVEST ESTIMATES FOR A RANGE OF COUNTRIES AND CROPS.
- (3) DEVELOP AND TEST PROCEDURES FOR ADAPTING REMOTE SENSING TECHNOLOGY TO DOMESTIC SMALL AREA (MULTICOUNTY) LAND COVER ESTIMATION AND THE INVENTORY AND ASSESSMENT OF US LAND, WATER AND OTHER RENEWABLE RESOURCES TO SUPPORT THE NATIONAL INVENTORY BY 1985.
- (4) DEVELOP A COST BASE TO HELP DETERMINE THE FUTURE USDA BUDGET LEVELS REQUIRED FOR INTEGRATING REMOTE SENSING TECHNOLOGY WITH THE EXISTING DATA AND/OR IMPLEMENT AN INDEPENDENT REMOTE SENSING DATA SYSTEM.

THE ROLE OF REMOTE SENSING IN THE DEPARTMENT OF COMMERCE
Donald R. Wiesnet (National Oceanic & Atmospheric
Administration
Washington, DC)

Under the Department of Commerce's Remote Sensing Program, 5 agencies contribute in various ways to the departmental effort. These agencies are —

- 1 National Oceanic & Atmospheric Administration (NOAA)
- 2 National Bureau of Standards (NBS)
- 3 Maritime Administration (MARAD)
- 4 National Telecommunications & Information Administration (NTIA)
- 5 Bureau of the Census (BOC)

The National Bureau of Standards (NBS) contributes indirectly by providing engineering data for design and construction of complex aeronautical and space equipment. The Maritime Administration (MARAD), uses satellites to increase efficiency of commercial ship communication, navigation and surveillance of operations. The National Telecommunications & Information Administration (NTIA), conducts remote sensing studies to support communication services. The Bureau of the Census (BOC), uses satellite data for oceanographic studies and population estimates.

By far, the largest remote sensing program is sponsored by The National Oceanic & Atmospheric Administration (NOAA), in support of its long-range goal, i.e., to improve safety and quality of life through greater comprehension of the Earth's environment and through more efficient utilization of its resources. NOAA and The National Environmental Satellite Service (NESS), contributes by operating, managing and improving the nation's operational satellite systems, and by providing satellite data to assess impact of natural factors and human activities on global food and fuel supplies and on environmental quality. The NOAA and the Office of Sea Grant, Office of Coastal Zone Management and National Ocean Survey, contribute by using satellite data and aerial photography for charting, coastal mapping and geodetic research. NOAA and The National Marine Fisheries Service, assist by employing satellite and aircraft data to improve assessment and conservation of marine life. NOAA and the National Weather Service contribute by using satellite data to improve weather and hydrologic forecast services by installing better radar systems and by continued atmospheric research.

NOAA and its predecessors have provided operational satellite coverage since April 1960 - nearly 20 years. Operational products such as sea surface temperature charts, snow and ice charts, etc., are available to all. Imagery, and more recently, digital computer tapes are available from the Environmental Data Information Service (EDIS). The National Environmental Satellite Service (NESS), collects 48 thermal IR images of the US every 24 hours and about 12 visible images per day from the Geostationary Operational Environmental Satellite (GOES). Additionally, NESS receives 2 thermal and 1 visible image from the polar-orbiting Satellite NOAA 6, which is the latest third generation polar orbiter.

DATA BASES/GEOGRAPHIC INFORMATION SYSTEMS

PANEL CHAIRPERSON (Association of Bay Area Governments
Donald A. Olmstead Berkeley, California)

Introductory Remarks

Remote sensing technology is rapidly merging with geographic information systems in a number of state and regional settings. Technical logic for this amalgamation is obvious - common geographic coverage and computer based data processing.

Perhaps a more potent driving force than technical logic, is the pressure for better information by government decision makers. Consider these points expressed by Paul Parker —

- 1 The decade of the 70's has brought increased awareness of our environment's complexity
- 2 Shortages demonstrated the finite nature of our resources and the uncertainty of the future
- 3 Public opinion requires government to allocate resources more efficiently
- 4 Government decision making is now exposed to more public scrutiny through the NEPA (and CEQA) requirements.

Like Utah, most states are in a period of transition and moderate to rapid growth. There are competing demands for resources. Issues quickly become complex and difficult, involving a wide spectrum of public interests.

Government decision making must respond to these situations quickly using current available information. Yet available information is often inadequate, unknown or inaccessible. When interagency data are available, their format, date, scale or classification are generally incompatible for comparison and analysis.

Geographic information systems are being built to tackle these problems. Such systems serve as a vital part of the new government decision making process, but they are not a panacea. We might do well to replace the old phase —

"Better data means better decisions"

"Better data is a necessary but not a
sufficient condition for better
decisions."

The point is simply that we can't keep up with the pressure of changing times without better data. Fundamental problems facing today's decision makers are institutional, not technical.

The institutional question is addressed in this session's papers from the point of view of those who are developing and operating geographic information systems. This question is being answered. What are the information needs we are trying to meet? How can we be an effective part of the decision-making process?

AEGIS & INFORMATION MANAGEMENT AT PG&E

Gregory M. Thornbury (AEGIS & Geographic Information Management
Pacific Gas & Electric Company
San Francisco, California)

Pacific Gas & Electric Company has been developing a geographic information system and a broad range environmental data base to respond to legislative mandates requiring more environmental information in the development of new energy facilities.

The geographic information system, called AEGIS, incorporates numerous automated data bases from a number of different sources. Both polygon and grid cell based data and software are used. Sophisticated modeling capabilities and high quality computer graphics are available for a wide range of studies. The software was developed by Environmental Systems Research Institute and transferred to PG&E's computer system.

Grid cell based data are used primarily for modeling of environmental concerns. Terrain unit polygon files have also been used for modeling in various studies. Terrain unit files provide a convenient mapping and storage concept for integrating maps of natural and physical features into a single automated file. More than 19,000 square miles of environmental data (28 variables) have been automated for 2 major data bases, covering major portions of the San Joaquin and Sacramento Valleys.

New capabilities to work with digital elevation data and LANDSAT data are being explored. LANDSAT holds particular promise for maintaining a current land cover/land use file on this data base. Computer based environmental variables potentially provide an ideal source of ground truth information and determinate layers for LANDSAT classification algorithms.

THE COMARC PLANNING INFORMATION SYSTEM (COMPIS) - NORTH CAROLINA
Robert Hall (Project Manager - COMARC Design Systems
 San Francisco, California)

COMARC is a planning consulting firm specializing in geographic information systems development. The system offered by COMARC for large-scale planning applications is called COMPIS (COMARC Planning Information System).

The COMPIS system has been adopted by the State of North Carolina. The configuration is a user-oriented system fully supported by user agencies. To date, the system has been used for 5 major applications —

- 1 Archaeological prediction
- 2 Application of the Universal Soil Loss Equation in
 taxing formulas for agricultural lands
- 3 Development of a land management plan for the Lee
 National Forest
- 4 Regional/Urban land use planning
- 5 Water quality analysis

Analysis of the potential affects of environmental regulations is an additional proposed use of this system.

THE DEVELOPMENT OF A STATE-LEVEL GEOGRAPHIC INFORMATION
SYSTEM IN UTAH

Paul H. Parker (Office of the State Planning Coordinator
Salt Lake City, Utah)

Development of a geographic information system in the State of Utah is in the formative stages. Current work involves 2 major topics - a Geographic Information System (GIS) feasibility study and an analysis of the barriers to GIS development in Utah.

Comments at the beginning of this section reflected the decision-making environment in Utah (and no doubt in other states). There is an ever-growing pressure for rapid decisions on environmental issues. There is an equally growing pressure for accurate and timely environmental data.

The basic approach in Utah is to address the decision-making process in conjunction with state information needs. The decision-making process is constantly being improved through 2 facets of the state's comprehensive planning process. The first, is the development and evaluation of alternative futures. The second, is a careful merger or interface between budgeting and planning functions.

Information needs are being addressed as they relate to the planning process. Currently, 3 areas are being examined —

- 1 Economic/Demographic Data
- 2 State Data Center for Census Data
- 3 Statewide Geographic Information System

Utah's GIS study is built on a comprehensive data needs survey designed to determine the state's geographic data needs. Interviews were conducted with agencies to determine —

- A description of the agency functions
- Data used to perform these functions
- What is routinely produced by the agency
- Additional data needs and intensity of need

From these interviews, a data needs matrix has been constructed. The matrix highlights data demand and common needs within the state. A

data item list has been compiled using source information sheets. These sheets include data item description and name, format, coverage, accuracy, update frequency, availability, cost and source. A Data Dictionary includes these source information sheets as well as agency contact person, cross reference and an index.

Follow up of the interviews involved creation of agency user groups, defined by common data needs. These groups reviewed the data needs survey and served as a focus for an educational process that included explanation of the GIS concept, objectives of the GIS study, output examples and a review of systems in other states.

A Landsat demonstration project through the University of Utah is a cooperative demonstration of needs in 3 agencies.

- The Division of State Lands (an assessment of range conditions and fire potential)
- The Division of Oil, Gas & Mining (determination of suitability for coal mining under new federal legislation)
- The Office of the State Planning Coordinator (pilot project to integrate Landsat data with other automated geographic data for statewide feasibility analysis)

Future steps in the Utah GIS study include development of data base specifications and an implementation plan.

In addition to the State GIS study, the Office of the State Planning Coordinator is also examining barriers to successful acceptance of information systems. Major barriers tend to be institutional and political, not technical and certain barriers are pervasive.

- A decentralized government structure resists centralization of data as a threat to individual control and flexibility.
- Multi-year projects (such as a GIS) are difficult to implement through annual budget cycles involving different branches of government.
- Control of information means control of power. Different branches of government may compete for that power.

- Costs of current data collection, storage and retrieval etc., are not available. Consequently, new systems are not seen as replacements, but rather as new costs since current costs are hidden.
- Better information and objective data may actually limit political flexibility and therefore are seen as creating loss of options and control.

THE ESTABLISHMENT OF AN AUTOMATED CENSUS MAPPING SYSTEM
& PROPOSED DEVELOPMENT OF A GEOGRAPHIC INFORMATION
SERVICE IN COLORADO

Dr. Louis Campbell (State Cartographer - Colorado Division
of Planning
Denver, Colorado)

Development of a geographic information system in Colorado is taking place within the already established Colorado Cartographic System. Colorado's mapping community operates within the planning function of the Local Affairs section in the executive branch of the state government.

The State Cartographer oversees operation of Colorado's Mapping Advisory Committee. The committee addresses mapping needs of 13 planning and management districts in the state. Together, the State Cartographer's Office and the Mapping Advisory Committee are working toward integration of the existing Colorado Cartographic System with a new Automated Census Mapping System and a Landsat Demonstration Project.

Fundamental to the eventual development of a statewide geographic information system in Colorado is the establishment of sound and accurate baseline data. A Geo-Data Indexing System (GDIS) has been established to organize baseline data acquisition. GDIS provides index maps of all data available in the state. The state maintains 100% coverage of high-altitude aerial photos and a new 1:50,000 scale map series is 75% complete.

Within the state, 2 counties and a regional (multi-county) agency developed dedicated geographic information systems. There is geographic overlap and therefore redundancy in two of these systems. In addition, these systems are redundant with a US Fish & Wildlife geographic information system developed in Colorado.

Evolution of a centralized, statewide geographic information system is beginning with a census mapping service being developed under a mandate from the Colorado Legislature. Under this mandate, the system must demonstrate operational capability by 1980. The system will first be used for reapportionment within the state.

A broader-based geographic information system will evolve incrementally from the census mapping system. Landsat will be merged into this system through a demonstration project in Pueblo County.

Donald A. Olmstead (Association of Bay Area Governments (ABAG)
San Francisco, California)

Many problems have surfaced as these information systems become entrenched in local government agencies. Many examples of overlapping coverage with no sharing of data exist. Classification schemes often do not match. Several coordinate systems and encoding schemes are used, precluding easy transfer of data and so on. There is waste through redundant capabilities.

To address this problem, NASA has funded a multi-year program to examine the problem of Vertical Data Integration in California, with an eye toward avoiding similar mistakes in other states not yet dotted with geographic information systems. The program is called the California Integrated Remote Sensing System (CIRSS). The purpose of the CIRSS program is to "facilitate the vertical integration of Landsat data into the various levels of California government".

The CIRSS program operates through a Task Force made up of representatives from local government, regional, state and federal agencies, two university systems, the legislature, a major utility and the private sector. The Task Force is advised by an Industry Advisory Panel comprised of representatives from the remote sensing industry.

The CIRSS program has 5 major goals —

- 1 Clarify the Vertical Data Integration concept
- 2 Test alternative approaches to Vertical Data Integration
- 3 Establish operational capabilities
- 4 Evaluate performance
- 5 Communicate CIRSS concept and project findings

The CIRSS Task Force adopted the following working definition of Vertical Data Integration —

"Vertical Data Integration refers to the general compatibility of data formats, classification methods and encoding routines whereby data collected about a geographic area by one agency can be selectively incorporated into the geobased information systems of other agencies at different levels of government with minimal data manipulation and reformatting."

The Task Force will adopt a set of technical and institutional elements which more clearly define day-to-day, operational components of Vertical Data Integration. These will then be used to evaluate 4 demonstration projects in the Fiscal Year 1979-80 program.

The FY 1979-80 program includes 4 demonstration projects and an operational alternatives study. Each demonstration explores a different approach toward integrating Landsat data into existing data bases. The 4 approaches differ in the method used to effect data integration and the lead agency responsible for driving the process. Each project involves users from at least 3 levels of government. Several demonstrations involve participants from the universities, public utilities and the private sector.

The CIRSS demonstration projects include —

Evolutionary Approach

This effort will examine how federal, county, public utility and private sector agencies use geo-referenced information once it is made available to the general public. Users in Northern California will be encouraged to incorporate the 1976 Landsat data base developed by the California Department of Forestry in cooperation with NASA/Ames and Jet Propulsion Laboratory into their existing systems with minimal outside assistance or training. This explains the term, evolutionary.

Networking Approach

The study will trace vertical/lateral flow of data from a central government agency to other users. The Association of Bay Area Governments (ABAG) will merge 1976 Landsat data into its computerized Bay Area Spatial Information System (BASIS), to provide a range of environmental-oriented data products to cooperating federal, state and county agencies and to a public utility company.

Developmental Approach

This project involves transferring a Landsat-based prime agricultural land change detection method developed by the University of California, Santa Barbara, to county, state and federal agencies. Using Fresno County as a test site, the university will provide user's with digitized land change data based on a comparison of 1976 Landsat data and a more recent Landsat scene.

Industry Assisted Approach

This study focuses on a private firm supplying digitized Landsat data. Cooperating agencies will include the US Forest Service, California Department of Forestry, San Bernardino County Planning Department and a major utility company. The project test site will be located in San Bernardino County. The project will be administered by a private firm.

In addition to the 4 demonstration projects, an Operational Alternatives Project will coordinate projects, prepare findings for review by the CIRSS Task Force and write final program documents. The Task Force will meet every 2 months to monitor projects using evaluation criteria adopted at the beginning of the program year.

SESSION V

19 OCTOBER 79 FRIDAY (AM)

WESTERN REGIONAL REMOTE SENSING CONFERENCE
CONVENED AT
THE NAVAL POST GRADUATE SCHOOL
KING HALL
MONTEREY, CALIFORNIA

SPONSORED BY NASA AMES RESEARCH CENTER
MOFFETT FIELD, CALIFORNIA

A THE ROLE OF THE NATIONAL CONFERENCE OF STATE LEGISLATURES
IN REMOTE SENSING

Paul Tessar (Natural Resource Information Project
Denver, Colorado)

Defining the primary remote sensing goals of the National Conference of State Legislature (NCSL), Paul Tessar (Director of NCSL's remote sensing project), pointed out 3 major goals.

- 1 The awareness of state legislators should be increased by educating them in as many aspects of remote sensing as possible.
- 2 Users must present a unified voice to the federal government to identify state requirements and uses of Landsat technology.
- 3 Users should provide feedback and insight to NASA to complement their help and assistance.

Mr. Tessar told attendees about 4 publications which might be of interest to those who want to keep abreast of NCSL activities —

- "A Legislator's Guide to Landsat"
- "State Institutional & Technical Approaches to Landsat Utilization"
- "Legislator's Guide to Natural Resource Information Systems" (New Publication)
- "NRIS Newsletter"

B OPERATIONAL USE OF THE TECHNOLOGIES

PANEL CHAIRPERSON (Department of Lands - Information Resources
Dr. M. Castro Division
 Phoenix, Arizona)

LANDSAT ADOPTION EXPERIENCE IN THE EASTERN REGION

Dr. Philip J. Cressy, Jr.

(Director - ERRSAC

NASA Goddard Space Flight Center
Greenbelt, Maryland)

The purpose of this presentation is, first to provide an overview of how the Eastern Regional Remote Sensing Applications Center (ERRSAC) at Goddard Space Flight Center is conducting business and how our states go about theirs. Then I will address the experiences of 3 states - Minnesota, New Jersey and Vermont - in adopting Landsat technology.

ERRSAC is responsible for Landsat applications transfer in 19 North-central and Northeastern states, the District of Columbia, Puerto Rico and the Virgin Islands. Statewide applications programs are nearing completion in Minnesota, Michigan, Maryland, Virginia, Vermont and New Jersey. Programs have recently been initiated in Ohio and New York and others are expected soon in Illinois and Delaware. Current programs involve 34 cooperative Landsat demonstration projects in a variety of application areas and included training for 75 state participants.

Landsat interpretation capabilities will either be developed within state government, or be accessible by them from local universities or private industry. In ERRSAC's region, over half the states have evolved a good resource relationship with local, especially land grant, universities. In these cases, primary Landsat capability resides, or will reside in the university. Vermont represents the best example.

Primary technical capability in several states is within state government itself. In the case of New Jersey, state investment is modest, but growing, while a university alternative does not currently exist. In the case of Minnesota, a major state investment in resource management and planning allowed buildup of internal capabilities to a substantial level. State agencies relationships with the University of Minnesota are good but they can get along without much help operationally.

Several of our states have turned to private industry for technical assistance. In most cases they obtained specific land cover/land use products under contract. In some cases information or statistics derived in part from such products were obtained. More and more state agencies participate in some way in actual Landsat data analysis as part of such contracts. Michigan's unique relationship with the Environmental Research Institute of Michigan (ERIM) as a provider of technical assistance includes training, consultation and access to ERIM analysis systems. As a rule, however, even with ERIM and Michigan, states seem inclined to

internalize the technology for routine use and to draw upon commercial support for specific projects.

Minnesota

The Legislative Commission on Minnesota Resources (LCMR) provides funding for "one shot" innovative resource management and environmental conservation programs of state agencies. (The funds come from a unique cigarette surtax). More than 12 years ago, LCMR supported establishment of the Minnesota Land Management Information System (MLMIS), then housed at the University of Minnesota. MLMIS was transferred to the State Planning Office, Land Management Information Center (LMIC), in 1977.

In 1979, LCMR provided new funding (More than \$ 300 K) for a major hardware/software upgrade of the MLMIS capability, including Landsat processing and product generation capability. Increased operating support, including manpower also developed. A cooperative Landsat demonstration program with ERRSAC included training of state and university personnel.

The standard method of operation of LMIC involves close cooperation with other state and regional agencies. ERRSAC projects reinforced this by involving LMIC in each others agency projects. Improved working relationships between state agencies and University of Minnesota researchers constitutes an important component of state capability. LMIC is buying Landsat data (NCIC Affiliate), and is engaged in Landsat projects independent of NASA.

New Jersey

The Department of Environmental Protection (DEP) was involved in an early Landsat investigation. While Landsat was not adopted as a tool by the organization then, several individuals within DEP acquired skills and appreciation for the technology. In 1978, personnel in the Department of Community Affairs (DCA) went quietly about implementing Landsat analysis software on state computers for use in land use planning programs.

The effort became public when DCA published a brochure in conjunction with their use of Landsat data for land cover analysis involving one third of the state as part of the New Jersey 208 program. Increased interest led to a statewide Landsat workshop in November 1978.

Immediately after the workshop, ERRSAC, DCA and DEP began a Landsat applications program. As a result of this program, nearly 20 people from the 2 departments are trained in Landsat data analysis and interpretation. Many participated in demonstration projects which further developed their skills. The state's inhouse analysis system, ARGOS, is now available to both departments. ERRSAC is assisting the state in upgrading this system. New Jersey has committed to acquiring hardware in support of this capability and has established a program to acquire/establish a statewide geobased information system.

Vermont

Vermont was involved in the initial Landsat investigation programs, largely in photointerpretation of imagery. Early interest by the Agency of Environmental Conservation enabled some Vermont personnel to obtain Landsat training at NASA's Earth Resources Laboratory. In May 1978, state concern for an imminent forest tent caterpillar infestation resulted in a Landsat project to identify affected areas. The project was ineffective, because of cloud cover and a lethal virus that all but exterminated the caterpillar. The by-product forest inventory aroused great state interest. Concurrent with growing, informed state interest, the University of Vermont became the first New England recipient of a NASA University Applications multi-year grant. Discussions among state and university, Regional Program and University Applications personnel, recognized the excellent resource relationship between state government and the university. While pursuing grant objectives, university personnel became working partners with state personnel in a Landsat applications program.

The university purchased image processing software for their computers and established state accounts, accessible from state offices. ERRSAC provided a 1 week training course in Vermont for 17 people. Vermont completed all but one of the cooperative projects and is preparing to initiate several Landsat projects of its own. Its capability, although not sophisticated, is sufficient for their needs. A recent federal grant to establish a geobased information system in the state will provide a culmination of Vermont's efforts to develop an operational natural resource and environmental management capability incorporating Landsat data.

These are the experiences of 3 states. Although they reached the goal in different ways, each of these states will, in terms of skills, facilities and institutional environment, be "operational" Landsat states by the summer of 1980. Their experiences constitute a guide to understanding the various aspects of technology adoption. They are not molds into which all states will fall. It is only important that a set of

institutional and technical skills and resources exist which enable a state to use Landsat as a tool in managing its own natural and environmental resources effectively.

THE PACIFIC NORTHWEST USE OF VICAR/IBIS
Doris Steingraber (Washington State University
 Computing Service Center
 Pullman, Washington)

A year ago, VICAR/IBIS was installed in the states of Washington and Idaho as part of NASA's technology transfer effort. The objective was to develop in-state image processing capabilities in these states. This paper will present rather briefly some VICAR/IBIS characteristics and especially its operation at Washington State University Computing Service Center. Instead of viewing these activities from the remote sensing application itself, observations will be made on the systems operational use from a data processing point of view and especially from within a state service center environment.

VICAR/IBIS is a general purpose image processing language. VICAR is an acronym for Video Image Communication & Retrieval. Functionally, it provides for typical image processing operations, such as image enhancement, geometric correction, multi-spectral classification. IBIS stands for Image Based Information System. IBIS functions address the actual utility of an image after it has been prepared. It provides for integration of non-image data for the information system development. It performs necessary district preparation functions to overlay census tracts, township boundaries, school districts, plus cross-tabulation, sorting, and reporting operations on selected combinations of these overlays. It also provides for interface to and from external tabular files.

VICAR/IBIS was developed by the Jet Propulsion Laboratory and released as a batch system. It runs on an IBM 360/65 or larger compatible computer and, for the most part, uses standard peripheral equipment which would typically be hooked to that type of machine. Operationally, it consists of a control language designed to minimize the need for learning the IBM Operating System Job Control Language. This feature definitely is an aid to system users. The system library provides over 200 programs. These programs are stacked together to produce a desired result.

A brief look at the university's objectives and operations environment of the Washington State University Computing Service Center is necessary to further evaluate VICAR/IBIS effectiveness in providing state image processing capabilities. WSUCSC is one of 4 state service centers established a few years ago by the Washington State Data Processing Authority. Our purpose is to provide a general data processing service to state, local or federal agencies on a cost-recovery basis. This means we are self sustaining and not funded by the university.

WSUCSC has an Amdahl 470 V/6 main frame with 8 megabytes of memory. There are about 10 billion bytes of online disk storage. A user tape library of about 16,000 tapes is maintained. An extensive amount of software is also made available to users of the WSU Computing Service Center. There are at least 14 different programming languages, 2 data base management systems, several statistical packages, as well as publication and thesis quality printing facilities. Online administrative applications are fully supported.

WSU's location in Pullman on the state's east side, has influenced the manner in which we operate as a state service center. Many Computing Service Center users are located in Seattle, Olympia and other remote locations. These agencies are linked into WSUCSC via a complex data communications network. Besides supporting WSU administrative and academic offices with terminals, there are about 30 Remote Job Entry (RJE) card reader/printer type stations and about 60 dial up users with CRT terminals. Our system supports the state Administrator for the Courts with 60-80 terminals and the state Library Network with about 120 terminals. As an example of system load, the number of jobs executed during May 1979 exceeded 102,000. It can be noted from this quick overview that the Computing Service Center has a well established user community requiring a committed level of support from our staff.

A major concern, therefore, in establishing an image processing service is the contention which may arise with other applications and its impact on the established user community. Image processing functions typically require considerable resources both for execution and data storage. With our current system capacity, decreasing costs of computing cycles and good planning, we currently anticipate no negative impact on our users. In fact, the user community benefits because of the availability of an additional processing capability.

Seven outside agencies are currently using VICAR/IBIS at WSUCSC. Even though VICAR/IBIS software full capabilities have probably not been utilized within the projects to date, there are some observations that can be made regarding the system's operation.

- Documentation — There is program documentation for each program. It briefly describes each program's purpose and identifies parameters for its use. Formal training sessions seem to be the realistic prerequisite for effective system use.

- System Architecture — Design of single function modules utilizing common input and output routines lend itself nicely to processing flexibility. This design simplifies system maintenance. It also makes it possible to easily incorporate user written functions which will help enhance system capabilities.
- System Effectiveness — This question has arisen regarding image classification. Additional clustering and editing functions have been supplied by Buzz Slye, NASA Ames Research Center to significantly enhance these capabilities.
- Strong Point — A definite system strong point is the IBIS (Image Based Information System) portion of the software which provides for integration of all data types.

Through PNRC grants and Washington State University Computing Service Center matching funds, VICAR/IBIS has been installed. VICAR/IBIS documentation does not entirely meet standards established by the Computing Service Center for supporting production software. NASA Ames Research Center provides excellent system support. As a result, we will be offering VICAR/IBIS as fully supported public software.

Work is being done on a PNRC training grant that provides for development of 3 one day seminars and a 4 day case study workshop to train individuals in the use of VICAR/IBIS.

Another PNRC grant will establish an interactive image processing laboratory using Stanford Technology Corporation's System 511. This facility is meant to supplement VICAR/IBIS capabilities. The lab will be located in Olympia, but maintained, scheduled and charged for by WSU Computing Service Center.

Our Operations Research group is actively investigating hardware/software to further supplement our image processing capabilities. We are looking at more sophisticated methods of handling the ever present data conversion problem of digitizing and entering these overlays. We also hope to provide high quality photo products in the near future.

Utility of new hardware/software by the general user community must be a considered factor in any acquisitions. It appears that the software available at the Computing Service Center will assist users in the development of operational data bases. Statistical packages and Data

Base Management Systems will be particularly useful. These capabilities should serve the advancement of the total information system concept.

In summary, VICAR/IBIS does have some holes in it, but, as data processing specialists, we feel it will definitely be a usable and supportable system. We will continue to identify any weaknesses and find ways to address them. We are aware that remote sensing technology did not develop overnight and neither did image processing technology. Therefore, we cannot expect to develop a production service to support utilization of these technologies overnight. We are making an effort and it looks promising.

SOUTH DAKOTA STATE PLANNING BUREAU'S REMOTE SENSING PROGRAM
William Ripple (State Planning Bureau
 Pierre, South Dakota)

Remote sensing activities at the South Dakota State Planning Bureau (SPB) were initiated in 1974 with a cooperative agreement between SPB and the EROS Data Center. A demonstration project was designed to gather statewide land use and land cover data using Landsat satellite imagery, plus high/low altitude aircraft photography. Under this cooperative project, EROS supplied technical assistance and imagery, while the state provided personnel to initiate and maintain an inhouse information system for interpreting, storing and applying resulting land use/cover data to South Dakota's planning needs.

In addition to statewide land use/cover data, SPB's Information System was designed to include soils, geology, topography and other natural resource data in its computer data bases. This ability to use land use/cover data in conjunction with other types of natural resource data, through the use of rapid computer analysis, enhances South Dakota's capacity to investigate internal land management problems.

SPB obtained the computer hardware/software needed to permit digital Landsat processing along with other geographic data analysis. The office has 2 terminals on line to the IBM 3031 computer at the University of South Dakota. In addition, the Bureau has a Tektronix 4051 that can be used as a stand alone mini-computer. It may also be interfaced with the IBM 3031, or with a summagraphics digitizer for spatial analysis.

All computer software for the system was developed inhouse. The Landsat Imagery Analysis Package (LIMAP) performs all functions necessary for analysis of digital Landsat tapes (Figure 1). Other software developed by the Bureau include the Digital Terrain Analysis Package (DTAP), used to map USGS digital terrain tapes and POLYGRID, a polygon-to-grid-cell conversion package.

Information obtained from the state land use/cover inventory has been used at the federal, state and local government levels, including the private sector, for land planning purposes. Remote sensing analysis conducted by SPB contributed land use and natural resource information for 208 water quality planning, comprehensive planning, corridor route selection studies, wildlife habitat studies and surface water inventories.

The 208 water quality investigation is a good example of how an operational Landsat system can be used for environmental planning. Under a recent 208 contract, SPB produced land cover maps from digital Landsat data and soil loss potential maps from digitized detailed soil surveys. Data availability in a similar digital format allowed data compositing to produce maps that illustrate erosion hazards (Figure 2).

Other applications have met the state's goal of providing technical assistance to local government units. For example, in the Spearfish Land Capability Study, NASA U2 photography was utilized to obtain land use and land use change data for the community. Land capability and land use data were composited to produce maps with statistics that relate to the area's physical limitations and changing land use patterns (Figure 3).

The operational Landsat program, along with the ability to digitally process a variety of natural resource data, provides SPB with analysis abilities beyond those possible from conventional data sources. These land resource data analysis capabilities within the State Planning Bureau continue to be refined and applied to land management and planning studies in South Dakota.

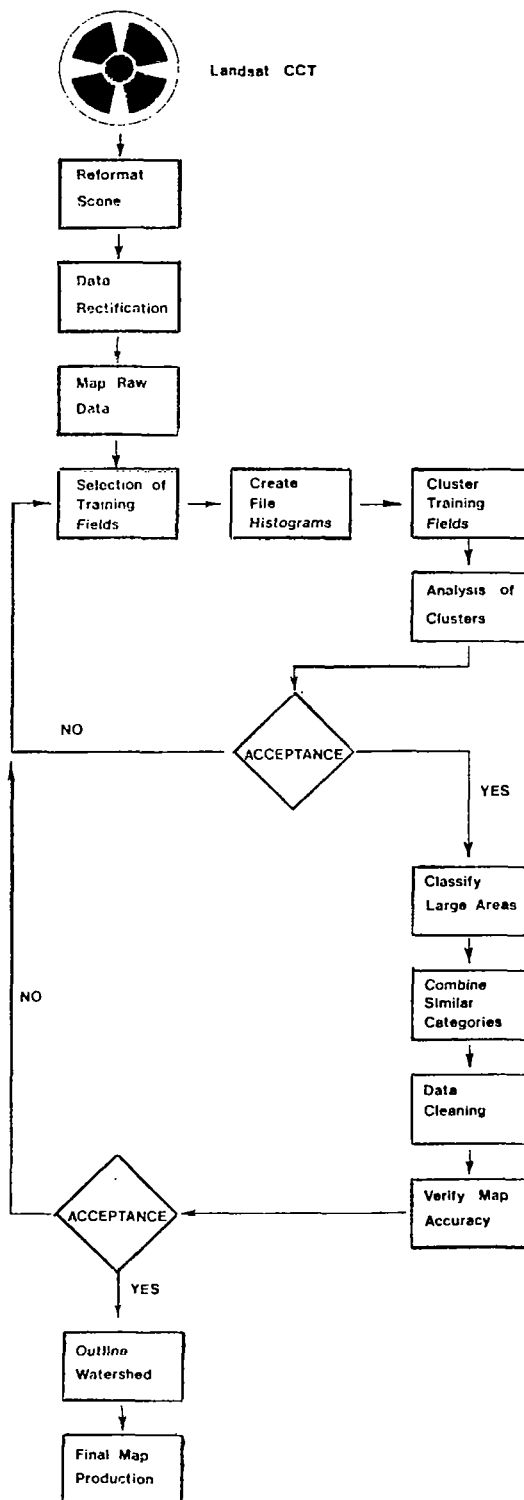


Figure 1 Analysis Procedure for Digital Land Cover Mapping

EROSION HAZARDS

SYMBOL	CATEGORY	TONS per ACRE	ACREAGE	PERCENT
	Slight	0 - 3	6,456	12.0%
	Moderate	3 - 6	29,794	55.1%
	Severe	6 - 12	11,545	21.3%
	Very Severe	12+	2,418	4.5%
	Nonsoil/Unavailable		3,832	7.1%

LAKE HERMAN WATER QUALITY STUDY AREA
EROSION HAZARDS

PRODUCED BY
SOUTH DAKOTA STATE PLANNING BUREAU

THIS IS A COMPOSITE MAP THAT ILLUSTRATES THE EROSION HAZARDS OF 1974 FOR THE LAKE HERMAN WATERSHED, LAKE COUNTY, SOUTH DAKOTA. 1974 LAND COVER DATA, OBTAINED FROM DIGITAL LANDSAT IMAGERY, AND THE FACTORS THAT COMPRISE THE UNIVERSAL SOIL LOSS EQUATION WERE OVERLAYED TO GENERATE THIS MAP. ACCORDING TO THE EQUATION, AVERAGE ANNUAL SOIL LOSS EQUALS "RKLSCF" WHERE R IS RAINFALL, K IS SOIL ERODIBILITY, L IS SLOPE LENGTH, S IS SLOPE GRADIENT, C IS VEGETATIVE COVER, AND P IS THE CONSERVATION PRACTICE. TO PRODUCE THE MAP, C VALUES FOR LAND COVER TYPES WERE ASSIGNED AS FOLLOWS: ROW CROPS=.51, SMALL GRAINS=.20, AND PASTURE=.013. IT WAS ASSUMED THAT NO SLOPE CONTOURING WAS USED (P=1). THE VALUES FOR THE SOIL LOSS FACTORS WERE OBTAINED FROM INFORMATION CONTAINED IN THE SOIL SURVEY OF LAKE COUNTY AND THE SOIL CONSERVATION SERVICE.

THE PREPARATION OF THIS MAP WAS FINANCED THROUGH A SECTION 208 WASTE TREATMENT MANAGEMENT GRANT FROM THE U.S. ENVIRONMENTAL PROTECTION AGENCY. FOR MORE INFORMATION CONTACT



LAND RESOURCE INFORMATION SYSTEM
SOUTH DAKOTA STATE PLANNING BUREAU
CAPITOL BUILDING
PIERRE, SD 57501
605-773-3628

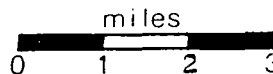


Figure 2 Erosion Hazards (Sheet 1 of 2)

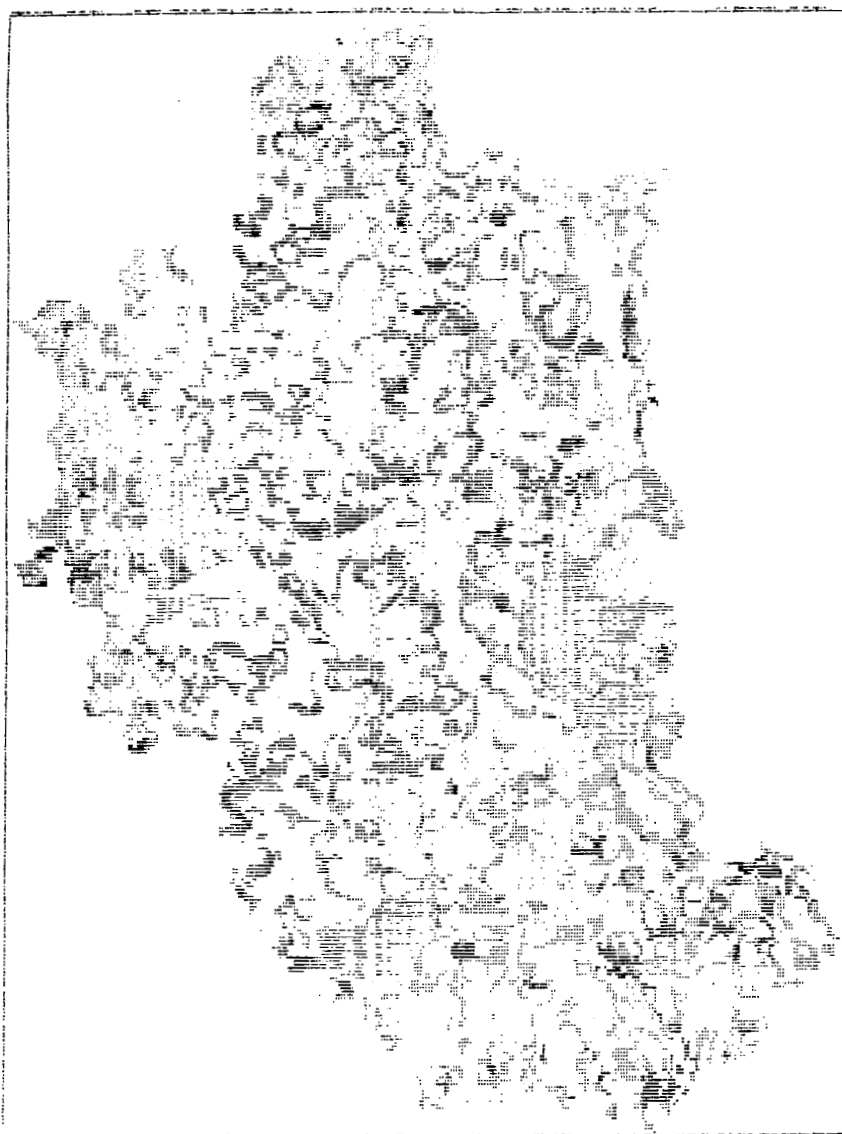


Figure 2 Erosion Hazards (Sheet 2 of 2)

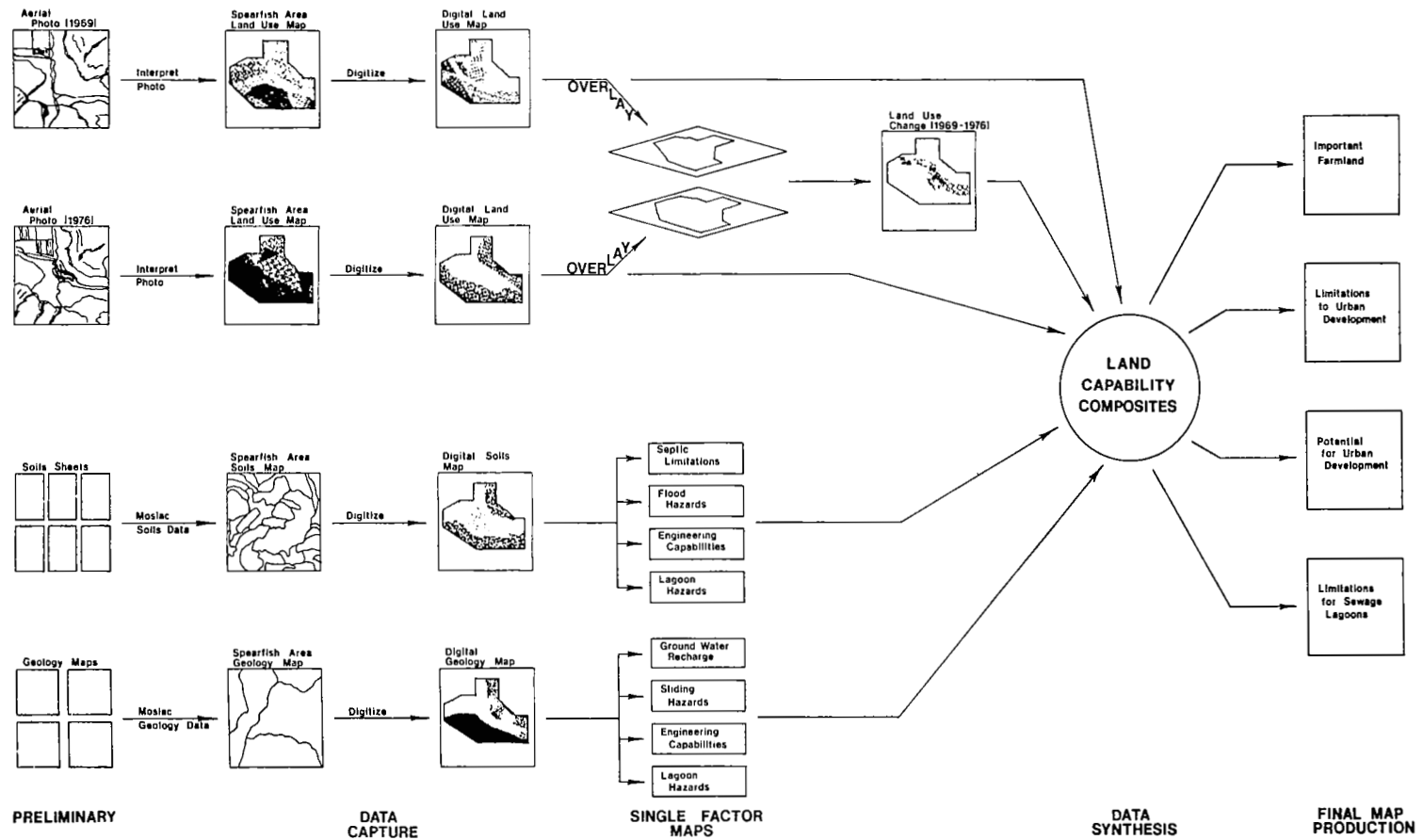


Figure 3 Spearfish Study Analysis Process

OPERATIONAL CONSIDERATIONS OF PRESENT & FUTURE LANDSAT
Dr. Stan Freden (NASA GSFC - Mission Utilization Office
Greenbelt, Maryland)

Dr. Freden of NASA's Mission Utilization Office discussed operational considerations of present and future Landsat satellites, including Landsat D, D' and D". He gave a brief history and status of present Landsat satellites. Specifically, he emphasized the tape recorder situation in Landsat 3 which allows use of both recorders for Return Beam Vidicon (RBV), but only 1 for Multispectral Scanner (MSS). This limit of recorder availability will result in emphasis on support from foreign ground stations with recording capability such as Sweden, Italy and Brazil. In addition, a possibility exists to set up portable ground stations in strategic locations, namely, Korea and China. Dr. Freden further pointed out that next year users will be able to obtain Computer Compatible Tapes (CCTs), which have not been geometrically corrected, so that one may perform any desired resampling and projection conversion from raw data. All necessary parameters will be provided on the tape header.

C

NEW TECHNOLOGIES

PANEL CHAIRPERSON
Dr. John E. Estes

(University of California - Department
of Geography
Santa Barbara, California)

SESSION SUMMARY

SPEAKERS

Dr. Alexander F.H. Goetz (NASA/JPL)
 Dr. Vincent V. Salomonson (NASA/GSFC)
 Dr. John E. Estes (Chairman UCSB)

The following material presented in tabular form presents the essence of the current systems characteristics of several advance sensors the National Aeronautics & Space Administration (NASA) has in preparation for the launch and planning stages. Of the 3 systems presented in this session, Landsat D, the Multispectral Resources Sampler and Stereosat, only Landsat D is an approved mission. This material is tabulated to identify where NASA is and their current planning direction in terms of sensors for earth observation.

Table 1 Comparison of Landsat D Thematic Mapper &
 Landsat 3 Multispectral Scanner

	Landsat D Thematic Mapper		Landsat 3 Multispectral Scanner	
	MICROMETERS	RADIOMETRIC SENSITIVITY (NE Δ P)	MICROMETERS	RADIOMETRIC SENSITIVITY (NE Δ P)
SPECTRAL BAND 1	0.45-0.52	0.8%	0.5-0.5	.57%
SPECTRAL BAND 2	0.52-0.60	0.5%	0.6-0.7	.57%
SPECTRAL BAND 3	0.63-0.69	0.5%	0.7-0.8	.65%
SPECTRAL BAND 4	0.76-0.90	0.5%	0.8-1.1	.70%
SPECTRAL BAND 5	1.55-1.75	1.0%	---	--
SPECTRAL BAND 6	2.08-2.35	2.3%	---	--
SPECTRAL BAND 7	10.40-12.50	0.5K (NE Δ T)	10.40-12.50	1.4K (NE Δ T)
GROUND IFOV		30M (BANDS 1-5) 120M (BAND 6)	79M (BANDS 1-4) 237M (BAND 5)	
DATA RATE		83 MB S	15 MB/S	
QUANTIZATION LEVELS		256	64	
WEIGHT		168 KG	75 KG	
SIZE		1.0 x 1.0 x 1.8M	0.35 x 0.4 x 0.9M	
POWER		250 WATTS	42 WATTS	
ALTITUDE		715 KM	917 KM	

Table 2 Proposed Multispectral Resources Sampler (MRS)
Sensor Characteristics

SPECTRAL RANGE	0.36 μ M to 1.0 μ M
SPECTRAL BANDS	4 ARRAYS, EACH WITH 2000 DETECTORS 5 SELECTABLE FILTERS/ARRAY BANDWIDTHS > 20 NM POLARIZATION FILTERS
SPATIAL RESOLUTION	15 METERS MAX
SWATH WIDTH/MODES	15 KMS AT 15 M (4 BANDS) AT 15 M (2 BANDS) 30 KMS AT 15 M (4 BANDS, 50% SAMPLING) AT 30 M (4 BANDS)
RADIOMETRIC SENSITIVITY	APPROXIMATELY 0.5% NE $\Delta\phi$ (8 BIT)
DATA RATE	15 MEGA BITS/SEC
POINTABILITY	2 AXES + 40° ACROSS TRACK ± 55° ALONG TRACK
SPEED OF POINTING	30°/SEC ACROSS TRACK 5°/SEC ALONG TRACK

Table 3 Stereosat Proposed Mission Parameters

<u>CAMERA SYSTEM</u>	THREE PUSHBROOM SCANNERS FORE, AFT AND NADIR
<u>SENSOR</u>	TWO 2,048 LINEAR ARRAYS PER CAMERA
<u>ORBIT</u>	LANDSAT CAPABILITY 700 KM, 98.2° INCLINATION SUN SYNCHRONOUS
<u>SWATH WIDTH</u>	61 KM
<u>RESOLUTION</u>	15 METER IFOV
<u>BASE-TO-HEIGHT RATIO</u>	1.0 AND 0.47
<u>COVERAGE CYCLE</u>	48 DAYS
<u>DATA TRANSFER</u>	TDRSS
<u>LAUNCH</u>	1984

SESSION VI

19 OCTOBER 79 FRIDAY (PM)

WESTERN REGIONAL REMOTE SENSING CONFERENCE
CONVENED AT
THE NAVAL POST GRADUATE SCHOOL
KING HALL
MONTEREY, CALIFORNIA

SPONSORED BY NASA AMES RESEARCH CENTER
MOFFETT FIELD, CALIFORNIA

A INDUSTRIES WORK IN REMOTE SENSING

PANEL CHAIRPERSON (Lockheed Electronics Company
Lowell Brigham Houston, Texas)

INDUSTRIES BASED UPON AIRBORNE SENSORS

Vern Cartwright (President - Cartwright Aerial Surveys
 Sacramento, California)

The benefits and applications of airborne sensors and photo support by industry was the focal point of Vern Cartwright's address. Mr. Cartwright, President of Cartwright Aerial Surveys of Sacramento, California, has been in the aerial survey field for 20 years.

He indicated that the government uses approximately 40,000 maps per year to transact business. These are products of both low level and high altitude sensors and 24 satellites in space. Mr. Cartwright indicated that through new techniques and special black box devices, it is now possible to determine X-Y-Z coordinates within inches from large distances.

ADVANCED EARTH RESOURCES ANALYSIS CAPABILITY
Gary E. Gnauck (ESL, Incorporated
Sunnyvale, California)

The scope of industries involvement in remote sensing is broad. It begins with the design, development and operational support of satellite launch vehicles, satellite platforms and associated sensors. To control satellites and to transmit data from sensors to the ground, industry developed spaceborne communications systems and associated ground data receiving stations. The final link in this sequence of events is the design, development and use of advanced digital processing systems which can be employed by the user to transform raw electromagnetic radiation data into meaningful information.

Many of you are just now, undertaking a study of remote sensing to determine how it may benefit your land use planning and land management tasks. To assist in this effort, I will provide an overview of a typical advanced image processing system and provide a few comments on its use and capabilities.

Figure 1 presents a Block Diagram of a typical digital processing system. Such a system consists of 4 major components: input, output, processing and interactive display.

Data for entry into such a system will consist of tabular file data, graphics vector data, analog film data and magnetic tape data in raster format. A number of input devices are typically provided to enter this diverse set of data into the system.

Similarly, a typical system will allow output of processed information in hard copy image format, vector plots on an x-y plotter, text and tabular information on a line printer, and, of course, magnetic tapes for storage or later processing.

Processing is typically performed on a minicomputer with associated system and data disks. Where large, time consuming functions are to be applied to data, a special purpose, high speed processor can be provided.

The interactive analyst station will usually contain a graphic CRT for edit and display of vector data, a CRT terminal for communication with the system, and one or more refresh CRT's (color/black/white) for display of original, intermediate and final processed data.

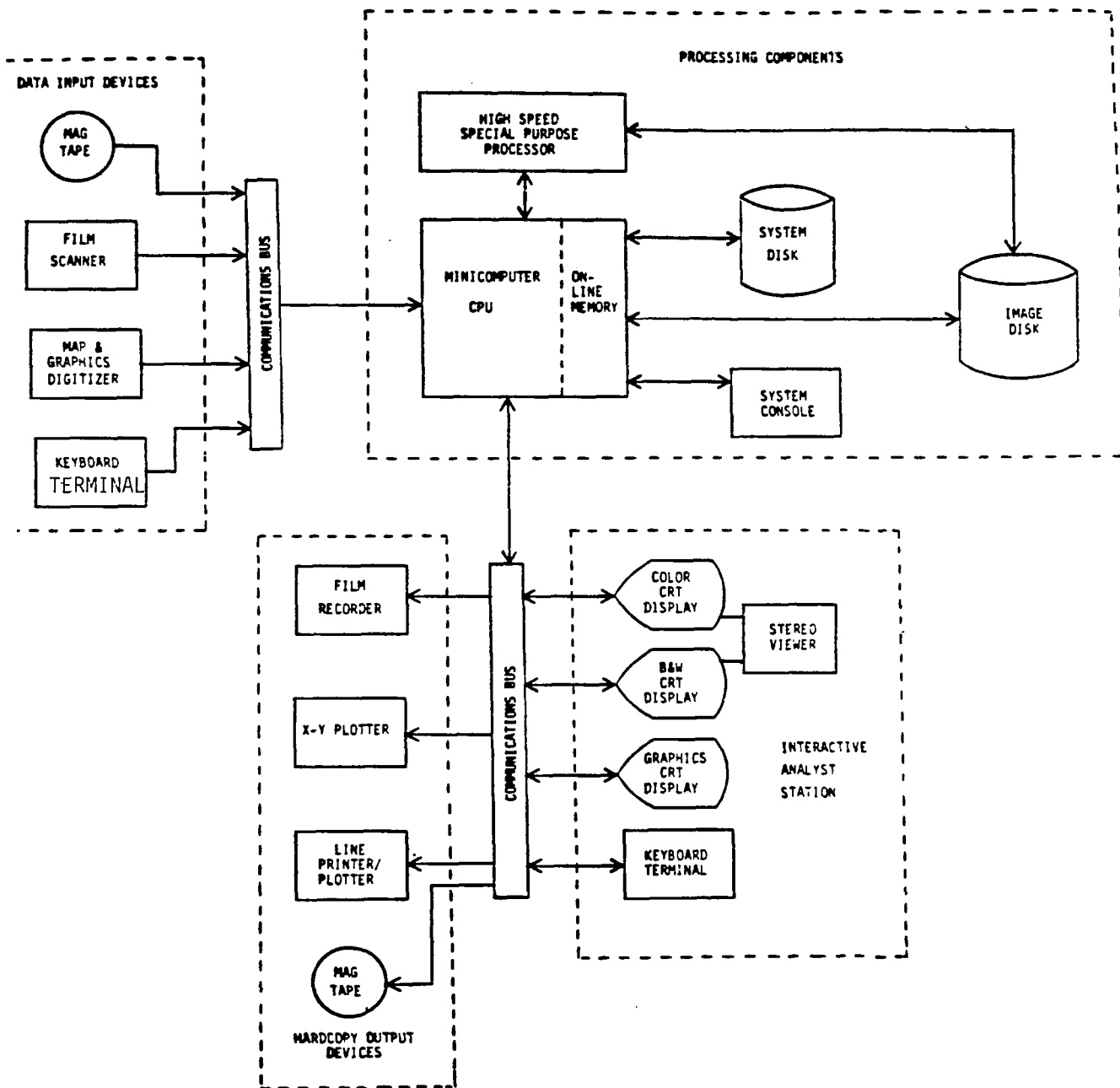


Figure 1 Typical Components of Advanced System Earth Resources Analysis System

Applications & Capabilities

Image processing systems provide a means to manipulate, enhance and process most types of remote sensing data. The type of processes or functions are many and varied, but consist of a few general categories.

Enhancement — Raw image data (single band/multiple band) can be enhanced through density slicing, pseudo coloring, contrast enhancement (exponential/linear/logarithmic), and edge enhancement (x or y or both) to provide the analyst with more information than contained in a single hard copy processed image. Rapidly changing the input parameters and obtaining immediate feedback via interactive CRT display is a distinct advantage over more conventional photographic enhancement processes.

Geometric Registration & Data Integration — Given sufficient data acquisition parameters, most types of remote sensing data can be corrected to a map base. Point, line and polygon data digitized from map overlays or aerial photos can be entered into the same data base and registered with the image data. Such a data base lends itself to statistical analysis, mensuration, arithmetical operations (e.g., add, subtract, divide) and logical operations (and, or, nor, =, <, >).

Multispectral Classification — A number of clustering and classification algorithms have been developed which can be applied to multispectral data to obtain thematic maps. Accuracies obtained with these processes, range from marginal to excellent.

Inventory & Sampling — To complement geometric registration and multispectral classification, various sampling schemes can be incorporated into the system to facilitate detailed ground survey and subsequent estimation of various resource management parameters.

Concluding Remarks

Advanced image processing systems are powerful tools that can be of significant aid in addressing planning and land management problems. These systems by themselves, however, will not solve planning problems, do an inventory or analyze an ecosystem. These tasks require experienced people to utilize a system in an efficient manner. The training and experience required cannot be over emphasized. I do not regard remote sensing as a discipline; but rather a complex tool that requires considerable experience and training to achieve maximum benefit from its application with an advanced image processing system.

A two week course in remote sensing or image processing is not sufficient to understand the tool. Anyone contemplating use of remote sensing should first consider a well planned technology transfer program essential.

REMOTE SENSING SERVICE INDUSTRIES

Lowell Brigham (Lockheed Electronics Company
 Houston, Texas)

Lockheed's Lowell Brigham substituted for George Wukelic of Batelle and presented "Remote Sensing Service Industries". Mr. Brigham stated that service companies can provide a wide variety of design, implementation, analysis, methodologies and hardware/software support services. In most cases, he stated, it is easier for a company to do business with the federal government because of RFP uniformity. He went on to discuss various companies involvement in support of remote sensing applications, identifying —

- Consulting firms
- Data Developers/Survey Companies/Computer Processing
- Companies working with data (i.e., Earthsat)
- Software products manufacturers (i.e., Culcomp)
- Hardware/Software systems manufacturers (ESL, Comarc)
- Hardware Producers (DeAnza/Tecktronix/CalComp)

Mr. Brigham cited examples of industry participation including: GE's work with the census, ESL's program for vegetation in Alaska and agricultural analyses performed by Earthsat.

He also indicated that Batelle will publish a list of firms in the remote sensing field and that copies should be available in early 1980.

B

WRAP UP SESSION

PANEL CHAIRPERSON (NASA Ames Research Center
Dr. Dale R. Lumb Moffett Field, California)

PANEL MEMBERS

Richard H. Weinstein
NASA Headquarters
Regional Applications Program
Washington, DC

Dr. William K. Dinehart
State of Utah
Division of State Lands
Salt Lake City, UT

Lowell Brigham
Lockheed Electronics Company
Houston, TX

Dr. Robert N. Colwell
University of California
Space Sciences Laboratory
Berkeley, CA

Dr. Gene Thorley
EROS Data Center
US Geological Survey
Sioux Falls, SD

WRAP UP SESSION SUMMARY

The WRAP UP SESSION was an open forum allowing for the summation of views and techniques presented at the conference.

Stressing the need for a logical and succinct methodology, Dr. Ida Hoos talked about developing a pattern for technology transfer. Hoos is with the Space Sciences Laboratory at the University of California, Berkeley.

Bill Dinehart, of the Utah Division of State Lands, called his state's remote sensing program an ambitious one. Despite obstacles, Dinehart said he is optimistic about the future of remote sensing in Utah. Citizen education, organizational structure, political support and adequate funding are areas where work is needed, he said.

After reviewing the university's role, Dr. Robert Colwell suggested that remote sensing technology transfer, like any other endeavor, is subject to the pitfalls of overselling, under-education, under-involvement and overkill. Colwell is with the University of California's Space Sciences Laboratory at Berkeley.

"To help, go where the action is," advised Lowell Brigham of Lockheed Electronics Company. Industry response is best in programs with adequate resources and enthusiastic participants, he said.

NASA Headquarters' Dick Weinstein thanked participants for making the conference a success. He expressed appreciation for government, industry and university contribution which help maintain a program as large and complex as remote sensing technology transfer. Although we have far to go, Weinstein said, our progress to date is encouraging. The future of Landsat technology transfer holds the possibility of practical and positive results, Weinstein said.

In conclusion, Panel Chairperson, Dr. Dale Lumb, thanked all of the speakers for their efforts and expressed praise for the supportive help and cooperation of industry, the universities, and the local, state and federal participants who contributed so significantly to making the conference both informative and productive.

APPENDIX A

SPEAKER PROFILES

ANDERSON Jim

Mr. Anderson was formerly with the Federal State Land Use Planning Commission for the State of Alaska.

Currently, Mr. Anderson is the Chief Coordinator and Planner of NASA Demonstration Programs for the State of Alaska - Department of Natural Resources in Anchorage, Alaska.

ARBOGAST Mary

Mary Arbogast has worked with the National Conference of State Legislatures in Denver, Colorado, for more than 2 years.

Since February, 1980, she has been affiliated with the California Environmental Data Center in the Governor's Office of Planning & Research & Coordination for the California Integrated Remote Sensing System Task Force.

BRIGHAM Lowell

Lowell Brigham is currently associated with the Lockheed Electronics Company as Program Development Manager for their Houston, Texas facility. He is an electrical engineer with a productive career in the area of advanced systems development for aircraft, spacecraft and ground data processing systems.

Mr. Brigham's expertise and experience spans over 12 years, beginning with the pre-Landsat era to General Electric's effort to design a Landsat based upon their military satellite and NIMBUS spacecraft experience. He was involved in the conceptual design of the Landsat Ground Station for Iran and with General Electric's User Applications Program.

Mr. Brigham moved to Lockheed 1 year ago which offered him an increase in responsibility while maintaining his involvement with remote sensing programs.

CAMPBELL Dr. Louis

Dr. Campbell is currently the State Cartographer for Colorado and Chairman of the Colorado Mapping Advisory Committee.

Prior to his present appointment, he was an Instructor in cartography at the University of Colorado where he received a PhD with specialization in Cartography.

CARTWRIGHT Vern

Vern Cartwright, President of Cartwright Aerial Surveys, has been involved in the field of Industrial Engineering and Aerial Surveys for more than 30 years. He organized his firm in 1946 to provide services in aerial photography, topographic mapping, remote sensing and photo-interpretation on a worldwide basis. In early 1979, Mr. Cartwright merged Datamap Systems, Inc., with his aerial survey company to provide capabilities in computer applications to cartography and to complement the entire interactive graphics department.

Mr. Cartwright is past president of the American Society of Photogrammetry, The National Legislative Council of Photogrammetry and has served 2 terms on the board of direction for the Northern California Chapter of the American Congress of Surveying & Mapping. He is also a member of the Advisory Board for Harvard's Graduate School of Design which deals with computergraphics and spatial analysis.

CAWLFIELD George

For the past 8 years, Mr. Cawlfeld has been associated with the State of Montana, primarily involved with the development and application of data processing systems in solving natural resource problems.

Mr. Cawlfeld is currently the Data Processing Manager for the Department of Natural Resources & Conservation, in Helena, Montana.

Previously, Mr. Cawlfeld conducted multifarious forest soil surveys for the US Forest Service. In addition, he was formerly affiliated with the Systems Development Corporation, providing programming, analysis and managerial services.

George Cawlfeld received his Bachelor's degree, majoring in Mathematics, from Montana State University. He also received a Master's degree, majoring in Soil Physics from Montana State.

COLWELL Dr. Robert N.

Dr. Colwell is a Professor of Forestry and Associate Director for the Space Sciences Laboratory - University of California, Berkeley. In addition, he currently serves as Director of the Earth Satellite Corporation, Berkeley office, and Editor in Chief of the Manual of Remote Sensing - Second Edition.

During the past 38 years, Professor Colwell has been actively engaged in full time teaching, research and public service as applied to remote sensing of natural resources. He has received numerous awards from the American Society of Photogrammetry, including the Sherman Mills Fairchild Photogrammetric Award for remote sensing applications to agricultural resources.

Rear Admiral Colwell also was awarded the Legion of Merit in October 1977 for his outstanding performance as Director of the Naval Reserve Intelligence Program. Shortly after, he received the William T. Pecora Award, generally regarded as the highest award presented in the remote sensing field.

Professor Colwell received his Bachelor's degree in Forestry and a PhD in Plant Physiology from the University of California, Berkeley.

CRESSY Dr. Phillip J. Jr.

Dr. Cressy is currently head of the Eastern Regional Remote Sensing Applications Center at NASA's Goddard Space Flight Center, Greenbelt, Maryland.

In 1972, Dr. Cressy was appointed scientific monitor of the ERTS (Landsat) program. He has conducted remote sensing investigations at Goddard that resulted in the development of the center's remote sensing technology training and transfer program.

Dr. Cressy received his Bachelor's degree in Chemistry from the College of St. Thomas, St. Paul, Minnesota. He attended the Carnegie Institute of Technology, where he earned a Master of Science and PhD in Chemistry.

DANGERMOND Dr. Jack

Dr. Dangermond is the Director of Environmental Systems Research Institute. Since founding ESRI in 1968, Dr. Dangermond has directed most of the firm's projects, including work throughout the United States and 5 world continents. Among the many important projects he personally supervised, are the Maryland Automated Geographic Information System (MAGI), the New Castle County, Delaware, 208 Program's Land Use and Environmental Information System (AERIS) and Santa Cruz County's Planning & Information System.

Projects that Dr. Dangermond directed abroad include the Dialand landscape simulation effort and the Fukuoka land use study in Japan, as well as newtown projects in France and Australia.

Dr. Dangermond has contributed extensively to literature dealing with use of the computer as a tool for land use planning, environmental analysis, geographic data processing, land capability and suitability studies and urban and regional data systems. He is recognized as one of the world's authorities in using computers for analysis and mapping geographic information.

Dr. Dangermond received a Bachelor's degree in Environmental Science from California Polytechnic College in Pomona. He earned 2 Masters degrees, one in Urban Planning from the Institute of Technology at the University of Minnesota and the other in Landscape Architecture from the Graduate School of Design at Harvard University.

DINEHART William K.

William Dinehart is Director of Utah's Department of Natural Resources, Division of State Land & Forestry. Prior to his appointment, he served 2 years as concurrent Director of Southeast Utah's Economic Development District and Association of Governments.

Among his many accomplishments, Mr. Dinehart managed Utah's Region VIII Law Enforcement Program, served as a Licensed Lobbyist to the state legislature and has taught at 3 colleges. He is a member of the Western States Land Commissioners Association and the Legislative Energy Task Force on SYNFUELS.

Mr. Dinehart received Bachelor degrees in Business and Management from the University of Maryland and in Geography/Regional Planning from Brigham Young University, where he also pursued graduate studies in Geography/Planning.

DUNDAS Thomas

Mr. Dundas has served as Director of Program Planning & Control in the Ocean Systems Division of North American Aviation Corporation in long Beach.

In September, 1979, Mr. Dundas was named Director of Montana's State Information System which is now located in the Department of Community Affairs. In that capacity, he directed the development and is responsible for the maintenance of a Statewide Information System.

EGGAN Dr. Lloyd

Dr. Egan is the Senior Systems Analyst and Data Base Coordinator for the Alaska Department of Natural Resources in Anchorage.

Currently he chairs design and technical groups that are developing the Alaska Land & Resource Information System (ALARS) within DNR, which will computerize resource assessment of 103 million acres of state lands. Dr. Egan also chairs an interagency group that is coordinating a cooperative data needs assessment among federal and state resource planning agencies in Alaska.

Dr. Egan received a Bachelor's degree from Pacific Lutheran University in Tacoma, Washington and his doctorate from the University of Wisconsin at Madison.

ESTES Dr. John E.

Professor Estes is currently associated with the Department of Geography for the University of California in Santa Barbara.

Dr. Estes has contributed to the field of remote sensing through his university service and his involvement with state and federal government and with private industry. His expertise and specialization include agriculture, land use and water resources application of remote sensing, regional resources development, geography of the Soviet Union, marine pollution monitoring and the interpretation of remotely sensed data.

Dr. Estes has authored more than 100 remote sensing publications. He received the coveted National Merit Teacher Award from the National Council on Geographic Education and a Presidential Citation from the American Society of Photogrammetry.

FALLAT Collin

Mr. Fallat is currently National Resource Analyst for the Office of the Governor for the State of Wyoming.

He was formerly Project Manager with jurisdiction of remote sensing and cartography for Environmental Research & Technology, Inc., an environmental consulting firm.

Mr. Fallat received his BA in Geography from Washington State University and an MA in Geography from the University of Nebraska. He is presently working on his thesis toward an MS in Natural Resource Management at Colorado State University.

FREDEN Dr. Stan

During Dr. Freden's 4 year affiliation at the Lawrence Livermore Laboratory, his work focused on high energy physics and space research. Dr. Freden was Director of the Geoparticle Section at the Aerospace Corporation from 1961 to 1968. He became associated with NASA in 1968 at the Manned Spaceflight Center where he remained until 1970.

In 1970, Dr. Freden joined The Goddard Spaceflight Center as Chief Scientist in the Laboratory for Meteors & Earth Sciences and later as Assistant Laboratory Chief. Dr. Freden is presently the Project Scientist for the Landsat Program at GSFC, a position he has held since 1974.

Dr. Freden received his BS and MS in Physics at the University of California, Los Angeles and went on to receive his PhD in Nuclear Physics from the same university in 1956.

GAYDOS Leonard

During Mr. Gaydos's tenure with the US Geological Survey, which began in 1973, he was one of the first to explore the potential of Landsat Digital Data. He presently represents the Survey at NASA Ames Research Center at Moffett Field, California, where he is in charge of a unit of the Geography Program involved in the development of Landsat applications. That unit is demonstrating uses of Landsat digital data in the Pacific Northwest, Northern Alaska, California and the High Plains.

His current interests and attention focuses on developing more accurate and efficient digital classification processes, methodologies for inventorying large multi-state regions and in assisting users not only in using but in understanding the data products developed from Landsat digital data.

Mr. Gaydos received his Masters degree in Geography from San Jose State University.

GNAUCK Gary E.

Mr. Gnauck has spent more than 15 years in the field of earth resources and remote sensing. As Manager of ESL's Earth Resources & Technology Applications Department, he supervises the scientific and analytical staff concerned with the technology that we are discussing at this conference. Gary will attest to the fact that industry in general and ESL in particular, can provide remote sensing analysis and services better and more cost effectively.

Mr. Gnauck's background in Forestry and Resource Economics provides the framework for an appreciation of remote sensing applications. Recent efforts include the management of an 8 million acre forest inventory program, Hawaii's Coastal Zone Management Program and a 3 million acre Wildlife & Range Vegetation Mapping program. These programs involved Landsat data combined with aerial photography, ground truth and historical data.

GOETZ Dr. Alexander F.H.

As a member of the Technical Staff with Bell Telephone Laboratories in Washington, DC, from 1967-1970, work included Apollo landing site geological experiments. He was the Principal Investigator for Apollo 8 and 12 orbital multispectral photography experiments.

In 1970, Dr. Goetz became affiliated with JPL to continue lunar studies and apply remote sensing techniques, particularly image processing, developed for planetary work to earthly problems. As Principal Investigator for ERTS and Skylab programs, he developed methods for remote geologic mapping and detection of mineralized zones using orbit multispectral imagery. He served as Manager of the Planetology & Oceanography section from 1975 to 1977. Dr. Goetz was the Development Project Scientist for Stereosat and Principal Investigator for the Shuttle Multispectral Infrared Radiometer scheduled aboard the second flight of Shuttle in 1981. Dr. Goetz main interest is to advance state of the art instrumentation and data analysis techniques for remote sensing of the earth's surface.

Dr. Goetz received a BS in Physics in 1961, an MS in Geology in 1962 and obtained CIT's first PhD in Planetary Science in 1967 from the California Institute of Technology.

GRABINSKI-YOUNG Nancy

Nancy Grabinski-Young is an Urban Planner for the City of Tacoma, Washington. She has been with the city since 1975 and has completed extensive work on implementing a geographic-based information system, remote sensing applications and related activities.

Nancy is a graduate of the University of Washington, Seattle, with a degree in Education.

HALL Madeline

Madeline Hall is currently the Project Manager for a statewide inventory of land use for the Oregon Water Resources Department.

As Research Scientist for the Environmental Remote Sensing Applications Laboratory, Corvallis, Oregon, she has participated in varied natural resource surveys for the past 3 years.

Her experience and expertise also includes a former position as Geographer for the Land Use Section of the National Eutrophication Survey, US EPA.

Madeline Hall received her BA from Macalester College, St. Paul, Minnesota, specializing in Geography and Biology and an MS from Oregon State University, with emphasis on Physical/Resource Geography.

HALL Robert

Mr. Hall is currently the Project Manager for Comarc Design Systems, a position he has held for 3 years.

He received his BS degree in Forestry from the University of California at Berkeley.

HANKINS Donna B.

Donna Hankins is currently the full time Project Director of Star Inc., a non-profit group which promotes remote sensing activities for the State of California. In addition, Ms. Hankins is responsible for writing, developing and publishing a remote sensing newsletter.

Previously, she was affiliated with the Humboldt State University, actively involved in remote sensing technology transfer. She has originated and presented many lectures and seminars, published papers and developed vu-graph, color slide educational aids dealing with natural resources, earth sciences and remote sensing technology and applications.

Her expertise in research and development focuses on geology, watershed management, land use, sedimentation processes, basin studies, aerospace technology and technology transfer methodology.

Ms. Hankins received a BA in elementary education from Iowa State Teachers' College in 1944. She received a BS in Geology from Humboldt State College in 1972. In 1973 she received an MA in Hydrology, specializing in Watershed Management, from Humboldt State College.

HARWOOD Peggy

Peggy Harwood is currently the Director of the Earth Resources Data Project, Council of State Planning Agencies and the National Governors' Association located in Washington, DC.

Harwood served as a staff member for 6 years on the Planning Program for the State of Texas, General Land Office in Austin, Texas. In addition, she is a GLO representative to the Texas Natural Resources Information System Task Force for 13 state agencies. Ms. Harwood is also Chairwoman of the TNIRIS Remote Sensing & Cartographic Committee and the Principal Investigator for a Landsat follow-on investigation for the Texas Coast.

Ms. Harwood served for 2 years with the Bureau of Economic Geology at the University of Texas in Austin and was the Photogeologist on the Geologic Atlas Project. Harwood's extensive experience and expertise also includes working as a photo interpreter of land use and hurricane hazards for the Environmental Geologic Atlas for the Texas Coastal Zones.

Ms. Harwood received her BA and MA in geology from the University of Texas at Austin.

HEDRICK Wallace E.

Mr. Hedrick is presently the Chairman of the Pacific Northwest Regional Commission Technology Transfer Task Force.

He is also Project Director of the Landsat Applications Program and head of Resources Northwest, Inc., Boise, Idaho.

HOOS Dr. Ida R.

Dr. Hoos is currently involved as a Research Sociologist as part of the social sciences staff at the Space Sciences Laboratory for the University of California, Berkeley, a position she has held since 1964.

Professor Hoos' interest and specialization is in technology transfer with particular emphasis on remote sensing.

Dr. Hoos' credits and accomplishments include serving as a Research Sociologist for the Institute of Industrial Relations from 1961 to 1963. She is presently on the Task Force for Nuclear Waste Management for the Nuclear Regulatory Committee, a position she has held since 1966. Dr. Hoos was a consultant to the Ford Foundation in 1962 and consultant to H.E.W. in 1964 and in addition, consultant to the US Civil Service Commission in 1965. She is on the Advisory Panel of the Directorate of Science & International Affairs - National Science Foundation, an appointment she has held since 1977.

As noted in the 13th Edition of "American Men & Women in Science" (Social & Behavioral Sciences Section), Dr. Hoos received her AB from Radcliffe in 1933 and her PhD from the University of Berkeley in 1959 majoring in Sociology. Dr. Hoos is a member of the American Sociologists Association, the American Sociological Society, the Institute of Management Sciences and the Operations Research Society of America.

JOHNSON Kim

Kim Johnson is Senior Water Resource Analyst for the Idaho Department of Water Resources. He has overall responsibility for development and application of varied remote sensing data for state water resource management.

Currently, Mr. Johnson is involved with the installation and maintenance of VICAR/IBIS software and development of criteria for operational irrigated cropland inventory.

Mr. Johnson received a BA in Geography from the University of Denver and an MS in Geography from the University of Idaho.

KRAUS Steven

Steven Kraus is currently with the Governor's Office of Planning & Research, State of California, in Sacramento, where he is serving as Program Coordinator for the multi-agency California Integrated Remote Sensing System (CIRSS) ASVT sponsored by NASA.

Previously, he served as an Environmental Planner with Dames & Moore and as a Staff Researcher with the Geography Remote Sensing Unit for the University of California at Santa Barbara.

He is presently working on a survey of data collection methods as part of the CIRSS project in cooperation with the California Environmental Data Center.

KROECK Richard

Mr. Kroeck is a principal and co-founder of Socio-tech Associates for Research (STAR). His 20 year association with remote sensing extends back to photo interpretation and interpretation research for the Army and for the CIA.

He managed Itek's Image Analysis Center working on projects that ranged from multispectral reconnaissance systems to photo interpretation equipment. Working for the World Resources Corporation, Mr. Kroeck directed their research in advanced remote sensing techniques as applied to natural resources.

Mr. Kroeck is well known for his work as Manager of ESL's Exploitation Support Laboratory and as the author of "Everyone's Space Handbook" distributed by Pilot Rock of Arcata, California.

His extensive and diverse background in technology, applications, public sector, large and small business experience enables him to represent small business service oriented organizations.

LAUER Donald T.

Mr. Lauer is Chief of the Applications Branch for the US Geological Surveys's EROS Data Center in Sioux City, South Dakota. In his current assignment, he administers and directs the EROS Data Center's domestic and foreign training and technical assistance programs. A team of scientists within the branch, provides state of the art remote sensing capabilities to resource scientists and land managers within the USDI, other cooperating agencies, and foreign countries, thereby assisting in technology transfer of proven remote sensing applications to users.

Among his impressive list of accomplishments, Mr. Lauer has served as consultant for the Lockheed Electronics Company, Houston, Texas and the University of Michigan in Ann Arbor. He is a contributing author to the American Society of Photogrammetry's "Manual of Remote Sensing," and held prominent positions in the Remote Sensing Research Program conducted by the University of California, Berkeley.

Mr. Lauer received his Bachelor's degree in Forestry from the University of California, where he also completed studies for a Master's of Science degree in Forestry and Remote Sensing.

LITTLE Gene R.

Gene Little is Deputy Supervisor - Services for the Washington State Department of Natural Resources. He has been affiliated with the department for more than 20 years, having served as Assistant Division Supervisor - Inventory and Division Supervisor of Technical Services.

He received a Bachelor's degree from the University of Washington, Seattle, and later earned his BSF from the same university.

LUMB Dr. Dale R.

Dr. Lumb became affiliated with NASA Ames Research Center in 1962, working for the US Army's Signal Corps. He remained at NASA Ames when he became a civilian employee for the Systems Engineering Division in 1964. Dr. Lumb has worked in the area of deep space communications, including telemetry and coding techniques, as well as serving as the Principal Investigator for a telemetry experiment on the Pioneer 9 spacecraft.

Currently he is the Chief of the Technology Applications Branch for the NASA Ames Research Center, which oversees the Western Regional Applications Program (WRAP). His specialized expertise is in translating applications of remote sensing data (including Landsat) to assist in solving problems for state and local agencies.

Dr. Lumb graduated from Kansas State University in 1958 and received a Bachelor of Science degree in Electrical Engineering. The following year, in 1959, he received his Master's degree in the same field from Kansas State. In 1962, he received his Doctorate from Kansas State in Electronics.

MASCY Alfred C.

Mr. Mascy has been associated with NASA Ames Research Center for the past 18 years, during which time he has authored more than 30 publications in the area of air and ground transportation systems, alternative energy sources, spacecraft rocket propulsion, space mission analysis, manpower, facility and budget assessments. Mr. Mascy was appointed as Assistant to the Executive Secretary of the National Aeronautics & Space Council, in Washington, DC, in 1971 where he remained until 1973.

Currently, Mr. Mascy is Manager of Information Systems & Services for the Western Regional Applications Program (WRAP), at NASA Ames Research Center. His highly developed and specialized expertise includes transferring timely information concerning NASA developed technologies and methodology to the general public.

Mr. Mascy is a graduate of Drexel University, Philadelphia, with a Bachelor of Science degree in Mechanical Engineering. He received his Master of Science degree from Stanford University in both Aeronautical and Astronautical Engineering in 1967.

MC ARDLE Richard C.

Mr. McArdle is currently the Remote Sensing Coordinator for the World Food & Agriculture Outlook & Situation Board, US Department of Agriculture. In addition to Departmental Coordination, his work primarily involves the development and implementation of the new AgRISTARS research program.

Previous assignments with the US Department of Agriculture include the Forest Service's Cartographic Photogrammetric unit and the Economic Research Service.

Mr. McArdle received his Bachelor and Master degrees in Forestry from the University of Michigan. He completed post graduate work at the University of Maryland in Economic Geography and Land Economics.

MOWER Dr. Roland D.

Dr. Mower is Director of the University of North Dakota Institute for Remote Sensing.

A Professor of Geography, Dr. Mower's visiting faculty appointments include Columbia and Stanford University. Dr. Mower spent the summer of 1979 as consultant to NASA Ames Research Center on the WRAP Program. In his paper, Dr. Mower describes his experience with the North Dakota Regional Environmental Assessment Program.

Dr. Mower received a Bachelor of Science degree from the University of Utah, a Master of Science from Oklahoma State University and a PhD from the University of Kansas.

MUNEKIYO Michael

Mr. Munekiyo is a Planner for the State of Hawaii Department of Planning & Economic Development.

Since 1977, he has chaired the Hawaii Ad Hoc Committee on Remote Sensing which is coordinating the state's Landsat demonstration program cooperatively with NASA WRAP.

Mr. Munekiyo received a Bachelor of Science degree in civil engineering from Colorado State University and a Master's degree in urban and regional planning from the University of Hawaii.

NUNNERY John

Mr. Nunnery is currently the long range Planning Administrator as well as Assistant Planning Director for the Planning Department of Spokane, Washington. He has been affiliated with Spokane County for 6 years and has contributed extensively in the development of a county-wide comprehensive plan.

Previously, he was associated with a civil engineering consultant firm in Wyoming and the US Navy specializing in electronics.

Mr. Nunnery has a Planning degree from Eastern Washington University.

OLMSTEAD Donald A.

Mr. Olmstead is the Director of the Bay Area Spatial Information System (BASIS), administered through the Association of Bay Area Governments (ABAG).

He received a Bachelor of Science degree in Geography/Mathematics from Illinois State University and a Master of Arts degree in Geography from the University of Washington.

PARKER Paul H.

Mr. Parker is currently the Director of Comprehensive Planning & Research in the Office of the State Planning Coordinator, Salt Lake City, Utah.

He received a Bachelors degree in Landscape Architecture from Utah State University. Mr. Parker is also a graduate of Harvard University with a Masters degree in Landscape Architecture.

PETTEYS Edwin Q.P.

Mr. Petteys has been affiliated with the Hawaii Division of Forestry since 1967.

As a Research & Technical Services Forester, his responsibilities involve resource inventories, mapping and remote sensing activities within the Division.

Mr. Petteys received his Forestry degree from Oregon State University, Corvallis, Oregon.

PORTER Alan

Mr. Porter is a Principal Planner for the Idaho Division of Budget Policy Planning & Coordination.

For the past 2 years, Mr. Porter has participated as Idaho's Representative, to the Pacific Northwest Regional Commission's Technology Transfer Task Force in the operation of their Landsat Applications Program.

RIPPLE William

Mr. Ripple is affiliated with the South Dakota State Planning Bureau as a Natural Resource Data Analyst, specializing in remote sensing/spatial information systems.

His extensive experience and expertise is in the area of computer information systems, demographic analysis, econometric modeling, land capability studies with emphasis on remote sensing.

Mr. Ripple received a BS in Geography from South Dakota State University and an MS in Geography from the College of Mines & Earth Resources from the University of Idaho.

ROBERSON Floyd I.

Mr. Roberson is the Director of NASA's Technology Transfer Division, a position he has held since 1978. Mr. Roberson's responsibilities encompass coordination of activities aimed at increasing public and private sector benefits derived from accelerated transfer of aerospace technology, including remote sensing applications.

Prior to becoming Director, he served as Special Assistant to the Associate Administrator for Space & Terrestrial Applications. Mr. Roberson has had extensive involvement with space technology applications since 1961. His contribution to Apollo 15 orbital science earned him the Exceptional Scientific Achievement Medal from NASA in 1971.

Selected as a Sloan Fellow, Mr. Roberson received a Master of Science degree in Management from Stanford University's Graduate School of Business in 1977. Mr. Roberson is also a graduate of Washington State University.

RUBINGH James L.

Mr. Rubingh was formerly affiliated with the Soil Conservation Service for the City of Greeley Planning Department and in addition, was part of the teaching staff with the University of Northern Colorado.

During the past 2 years, he served as a Resource Analyst for the Colorado Department of Agriculture.

As Chief Investigator in the Critical Agricultural Lands Project, Mr. Rubingh has utilized satellite imagery in development of state land cover maps, with computer mapping systems to pinpoint areas of land conversion.

Mr. Rubingh received a BS in Biology from Grand Valley State College and a MA in Biological Sciences from the University of Northern Colorado. He received an MS degree from Colorado State University, specializing in Regional Resource Planning.

SALOMONSON Dr. Vincent V.

Dr. Salomonson is Chief of the Hydrospheric Sciences Branch in the Laboratory for Atmospheric Sciences, Applications Directorate at Goddard Space Flight Center and the Project Scientist for Landsat D. At Goddard he has been engaged in studies seeking to assess the applications of space technology to meteorology and water resources management for the past 11 years.

Prior to his appointment at Goddard, he spent 3 years as a Weather Officer in the US Air Force.

Dr. Salomonson has authored over 70 publications in scientific journals, conference proceedings and NASA reports.

His academic background includes a BS in Agricultural Engineering from Colorado State University, a BS in Meteorology from the University of Utah, an MS in Agricultural Engineering from Cornell University and a PhD in Atmospheric Science from Colorado State University.

SAWYER Glenn B.

Mr. Sawyer has been associated with the California Department of Water Resources for the past 25 years. His expertise and primary involvement is in the area of land use and related water demand studies.

Mr. Sawyer is currently Chief of the Water Conservation & Use Section of the Division of Planning. He has jurisdiction and responsibility for statewide collection and analysis of land use and water use data.

SCOTT Robert B.

Robert B. Scott is currently affiliated with the State of Washington, Department of Natural Resources where he is involved in the development of operational applications for remote sensing. He has been with the State of Washington for the past 9 years.

Mr. Scott served as an Officer in the Royal Canadian Engineers in World War II. His extensive experience includes 9 years as Exploration Geologist in Canada and Africa as well as 14 years as an Aerospace Manufacturing Research Engineer.

He is an Officer of the Puget Sound Region of ASP and past Chairman of the North Pacific Region of AIME.

In 1946, Mr. Scott received a Bachelor of Arts & Science degree, majoring in Mining Engineering & Geology from the University of Toronto, Ontario, Canada.

SLOSKY Leonard

Leonard Slosky served as Staff Assistant to the Governor of Colorado and as Special Assistant to the Executive Director of the Colorado Department of Highways.

Mr. Slosky is currently Staff Director of the Natural Resource & Environment Task Force, Intergovernmental Science, Engineering. In addition, he is a member of the Technology Advisory Panel, Executive Office of the President, an appointment he has held since 1977.

SMITH Ronald

Mr. Smith is Supervisor of Game Research Projects for the Arizona Game & Fish Department. Mr. Smith has served the State of Arizona for the past 21 years.

He is interested in numerical and graphical analysis of data and is currently trying to evaluate the use of Landsat for more general applications.

Mr. Smith received a BS degree from the University of Massachusetts, Boston, specializing in Wildlife Management and an MS degree from Utah State University majoring in Wildlife Management.

STEINGRABER Doris

Doris Steingraber is currently a Systems Analyst with the Software Services Division, Computing Service Center, Washington State University. She has participated in the development and utilization of computerized mapping systems for natural resource management and land use planning applications. Since 1978, work has focused toward development of image processing capabilities at WSUCSC.

Previously, Ms. Steingraber was associated with Control Data Corporation, Minneapolis, where she was involved in the development of diagnostic software for newly designed hardware. She has served as Systems Consultant to faculty and graduate student researchers since joining the staff at WSU in 1968.

Ms. Steingraber received a Bachelor's degree in Mathematics from the University of North Dakota.

SYVERTSON C.A.

Mr. Syvertson is the Director of NASA Ames Research Center, Moffett Field, California. He has held this position since 1978.

Prior to his appointment as Director, he was Deputy Director of Ames Research Center. In 1970-71, he served with the Department of Transportation in Washington, DC, where he was Executive Director of the Joint DOT-NASA Civil Aviation Research & Development (CARD) Policy Study. In 1971, he received the NASA Exceptional Service Medal for his leadership of the CARD Policy Study. Earlier awards include the Lawrence Sperry Award of the American Institute of Aeronautics & Astronautics and the Space Act Invention Award (shared with three others). He was named a Fellow of the American Institute of Aeronautics & Astronautics in 1976 and a Fellow of the American Astronautical Society in 1978.

Mr. Syvertson received a Bachelor of Aeronautical Engineering degree from the University of Minnesota in 1946 and an MS degree in 1948. He is a 1977 graduate of the Advanced Management Program of the Harvard Business School.

TESSAR Paul

Paul Tessar has held the position of Director for the Natural Resource Information Systems Project of the National State Legislatures for the past 3 years. In this capacity, he has been responsible for providing information and technical assistance to State Legislators and staff interested in the utilization of Landsat and Information Systems Technology.

He has also been responsible for working with the federal government in developing programs to assist the states in their use of Landsat and other natural resource data.

Previously, Mr. Tessar was the Director of the South Dakota Planning Information Service where he was responsible for designing, developing and managing the South Dakota Land Resource Information Systems. The system includes operational capabilities for digital Landsat Analysis and applications and for matching Landsat and other data types such as soil surveys and digital terrain data.

Mr. Tessar received his Masters degree in Urban & Regional Planning from the University of Illinois, Urbana, Illinois in 1974, specializing in Information Systems & Quantitative methods. He received a Bachelors degree in European History in 1972.

THORNBURY Gregory M.

Mr. Thornbury is a Planning Analyst for the Urban & Regional Planning Section of Pacific Gas & Electric's Land Department in San Francisco.

Mr. Thornbury received a Master's degree in Urban Planning from the University of Illinois and a Bachelor's degree in Natural Resources & Environmental Science from Purdue University.

THORNHILL R. Ronan

Mr. Thornhill, Forester & Resource Planner for the Nevada Division of Forestry, is responsible for the statewide Forest Inventory Program which is being conducted in conjunction with the US Forest Service and the Bureau of Land Management (BLM). In addition, he is responsible for the Pilot Forest Inventory using the techniques of Landsat imagery and high altitude aerial photographs. He is Coordinator for the division's program planning effort between the state office and 3 area offices.

Mr. Thornhill is a graduate Forester from the University of Nevada, Reno, with a minor in Recreation & Military Science (Commissioned 21st US Army).

TOSTA-MILLER Nancy

Nancy Tosta-Miller is currently the Project Manager for the California Division of Forestry (CDF) - NASA Remote Sensing Project.

In 1976, Ms. Tosta-Miller joined CDF as a Soil Scientist after having been associated with the Remote Sensing Research Program for the University of California, Berkeley. Prior to her appointment as CDF Project Manager, she transferred within the department to the Forest Resources Assessment Program (FRAP), as a Resources Specialist with expertise in remote sensing and soils.

Ms. Tosta-Miller received a Bachelor of Science degree in Soils & Plant Nutrition from the University of California, Berkeley, where she also earned a Master of Science degree specializing in Soil Science.

WATKINS Allen H.

Allen Watkins joined the US Department of Interior as Chief of the EROS Data Center in September 1973. He directs principal activities of the EROS Program, managed by the US Geological Survey, and oversees the reception, preparation and distribution by the Data Center of high altitude information to all users - government, private industry and the general public.

Prior to joining EROS, Mr. Watkins served as Assistant Program Manager, Earth Resources Program, at Johnson Space Center. He was affiliated with the Skylab Earth Resources Experiment Package and Earth Resources Aircraft Program, while assisting in the direction of more than 500 engineering and scientific personnel working on acquisition and management of earth resource data.

Mr. Watkins received a Bachelor's degree in Metallurgical Engineering from the Virginia Polytechnic Institute.

WEINSTEIN Richard H.

Richard H. Weinstein has been the Manager of NASA's Regional Remote Sensing Applications Program since 1977. He is responsible for nationwide training and technology demonstration activities for transferring the ability to utilize Landsat technology to state and local governments.

Mr. Weinstein began his career with NASA in 1959 as a Physicist, with achievements in the area of plasma physics, space shuttle and orbital systems technology and environmental quality program management. Prior to his current appointment, he spent 2 years as Executive Officer to NASA's Associate Administrator for Center Operations which is responsible for the agency's institutional operations.

Mr. Weinstein is a graduate of the Massachusetts Institute of Technology and the Virginia Polytechnical Institute.

WESTERLUND Dr. Frank

Dr. Westerlund is an Assistant Professor of Urban Planning for the University of Washington, Seattle. Currently, Dr. Westerlund is on loan to NASA WRAP to assist in user liaison and program planning.

Dr. Westerlund's interest in remote sensing began in the late 1960's, where he joined the staff of a Bay Area planning firm involved in aerial photographic land use surveys. Since 1971, he has completed research projects and teaching assignments for the Remote Sensing Applications Lab at the University of Washington, which includes a "User Needs Study" for the Pacific Northwest Land Resources Inventory Demonstration Project.

He is co-author of the recent book, "Remote Sensing for Planners", published by Rutger's.

Dr. Westerlund received a Bachelor's degree in Architecture from Stanford University and a Master's degree and a PhD in Urban Planning from the University of Washington.

WIERMAN Dale

Dale Wierman is currently involved in the Forest Resources Assessment Program.

Mr. Wierman served as Assistant Program Manager for the Forest Resource Assessment Program, US Forest Service, for 5 years in conjunction with the Washington State University's "Forest Management Program".

During his tenure with the California Department of Forestry, as Staff Forester, his work involved various issues and tasks with reference to the forest resource values of California which required extensive effort working with state and federal legislative processes.

WIESNET Donald R.

Mr. Wiesnet is a Senior Research Hydrologist, Environmental Sciences Group, for the National Oceanic & Atmospheric Administration (NOAA), National Environmental Satellite Service (NESS).

Previously, Mr. Wiesnet served as a Geologist for the US Geological Survey from 1952 to 1967 and was the agency's first Geohydrologic Map Editor.

He has authored many published articles and papers on remote sensing, geology, geophysics, satellite hydrology and geohydrology in scientific journals and government publications. In addition, he was General Chairman of the Fifth Pecora Memorial Symposium on Remote Sensing - the first symposium ever held on satellite hydrology.

Mr. Wiesnet received his Bachelor's degree, Masters and Teaching Certificate from the University of Buffalo (State University of New York), and performed Advance Graduate work at the University of Arizona. He is a Fellow of the Geological Society of America.

APPENDIX B

LIST OF ATTENDEES

LIST OF ATTENDEES AT THE
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MONTEREY, CALIFORNIA
October 17-19, 1980

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